



Synchrotron Soleil

Extension zone RF

Note de calcul complémentaire

Stabilité horizontale de la charpente métallique

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1. HISTORIQUE DES REVISIONS

Rév.	Date, Signature et repérages des paragraphes modifiés
A	Rédacteur : Hassan ALAMEH Vérificateur : Cédric GARBAY Approbateur : Julien DEROSNE Première émission. 09/2025

2. REFERENCES

2.1. NORMES ET GUIDES

- [1] NF EN 1993-1-1 Eurocode 3 – Calcul des structures en acier – Règles générales et règles pour les bâtiments

2.2. DOCUMENTS PROJET

- [2] Mail SYNCHROTRON SOLEIL - Extension zone RF (91-ST AUBIN) - RICT (15 septembre 2025)

2.3. LOGICIELS

- [3] ROBOT STRUCTURAL ANALYSIS Logiciel de calcul par éléments finis, version 2021

3.OBJET DE L'ETUDE

La présente note de calcul complémentaire, réalisée suite au mail du 15 septembre [2], a pour objet d'intégrer l'effet d'aplomb dans l'analyse de la structure, afin de confirmer sa stabilité horizontale.

Les chargements considérés sont identiques à ceux de la note précédente, auxquels s'ajoute une charge horizontale représentative du défaut d'aplomb.

4.CONTEXTE DU PROJET

4.1. CALCUL DU DEFAUT D'APLOMB

L'objectif est d'introduire une charge horizontale représentant le défaut d'aplomb de la structure. Conformément au §5.3.2 (4) de la NF EN 1993-1-1[1], les défauts d'aplomb peuvent être négligés si la somme des efforts horizontaux est supérieure à 15% de la somme des efforts verticaux, pour l'ensemble des combinaisons ELU.

Le défaut d'aplomb global est déterminé suivant les formules ci-dessous.

a défaut initial global d'aplomb, voir Figure 5.2 :

$$\phi = \phi_0 \alpha_h \alpha_m \quad \dots (5.5)$$

où :

ϕ_0 est la valeur de base : $\phi_0 = 1/200$

α_h est le coefficient de réduction pour la hauteur h applicable aux poteaux :

$$\alpha_h = \frac{2}{\sqrt{h}} \text{ mais } \frac{2}{3} \leq \alpha_h \leq 1,0$$

h est la hauteur de la structure [en mètres] ;

α_m est le coefficient de réduction pour le nombre de poteaux dans une file :

$$\alpha_m = \sqrt{0,5 \left(1 + \frac{1}{m} \right)} ;$$

m est le nombre de poteaux dans une file, en n'y intégrant que les poteaux supportant une charge verticale N_{Ed} supérieure ou égale à 50 % de la valeur moyenne par poteau dans le plan vertical considéré.

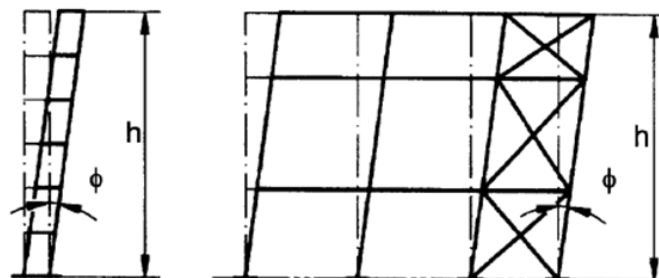


Figure 5.2 Imperfections équivalentes d'aplomb

Figure 4-1 : Imperfection équivalentes d'aplomb - Extrait de [1]

4.2. DESCRIPTION DU MODELE

Ci-dessous les vues et les caractéristiques de la charpente :

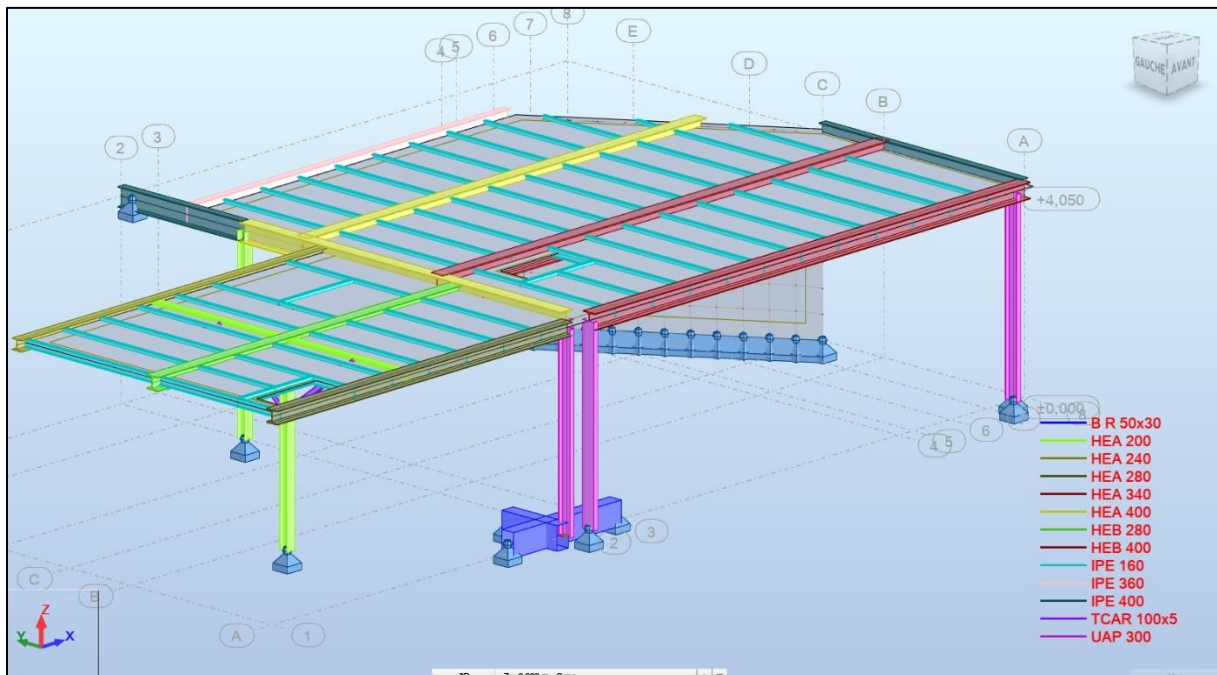


Figure 4-2 : Profilés

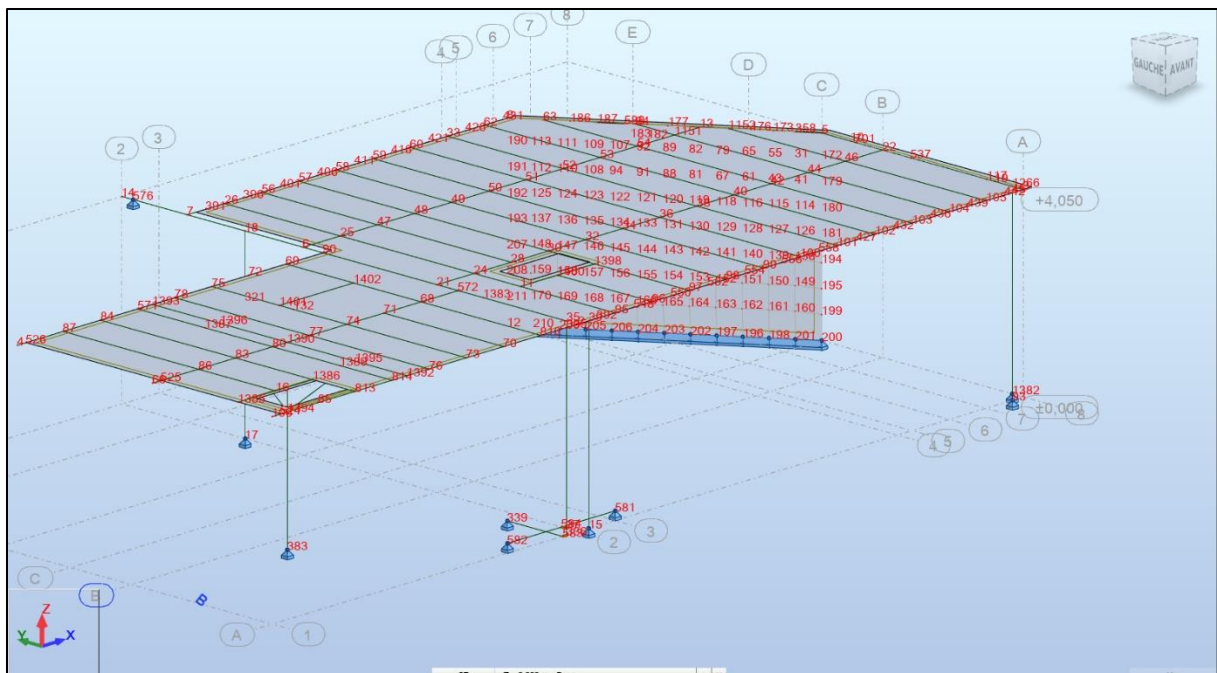


Figure 4-3 : Nœuds

Les poutres sont relâchées autour des axes locaux y et z soit des degrés de liberté bbblll, où « b » signifie bloqué et « l » libre.

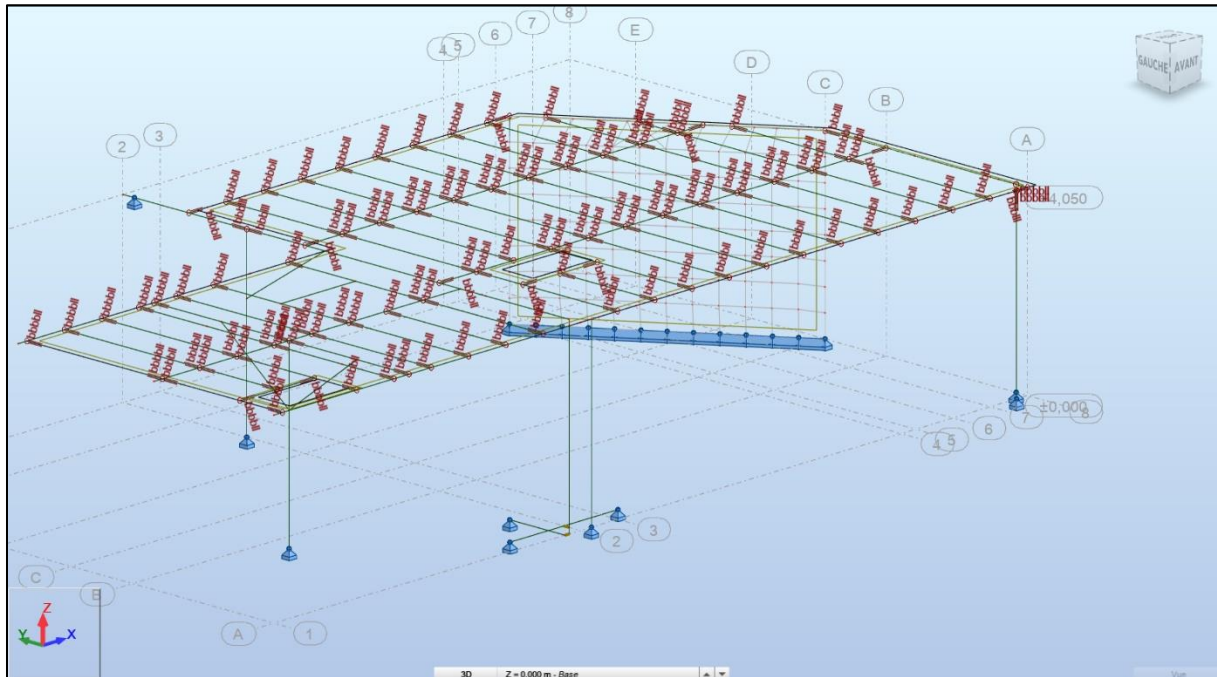


Figure 4-4 : Relâchements

NOTA : le poteau entouré en rouge est encasturé en tête et articulé en pied, soit une stabilisation suivant l'axe X ; le poteau entouré en vert est encasturé en tête et en pied, soit une stabilisation suivant les axes X et Y ; le poteau entouré en bleu est articulé en tête et en pied mais est lié à une traverse via un bracon, soit une stabilisation suivant l'axe Y. La stabilisation dans les 2 directions horizontales est donc assurée d'une part, par les poteaux de la charpente métallique, et d'autre part, par les appuis sur le génie civil existant.

Tous les appuis de la structure sont des appuis rotulés (rotations libres et translations bloquées), dont les degrés de liberté sont bbblll, où « b » signifie bloqué et « l » libre.

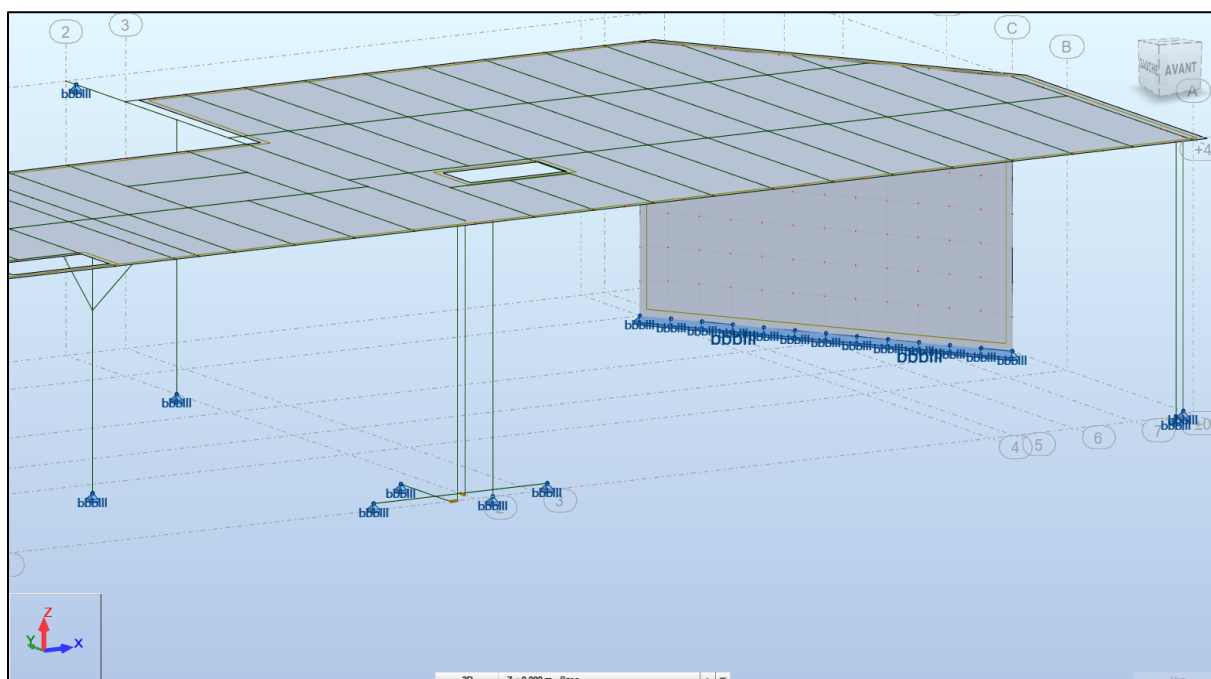


Figure 4-5 : Appuis

4.3. CHARGEMENTS

4.3.1. CHARGES PERMANENTES

4.3.1.1. CAS DE CHARGE 1 – POIDS PROPRE

Le poids propre de la dalle est automatique généré par ROBOT [3] à partir du volume des éléments structuraux et de leur poids volumique ; cette charge est majorée de 5% pour les assemblages.

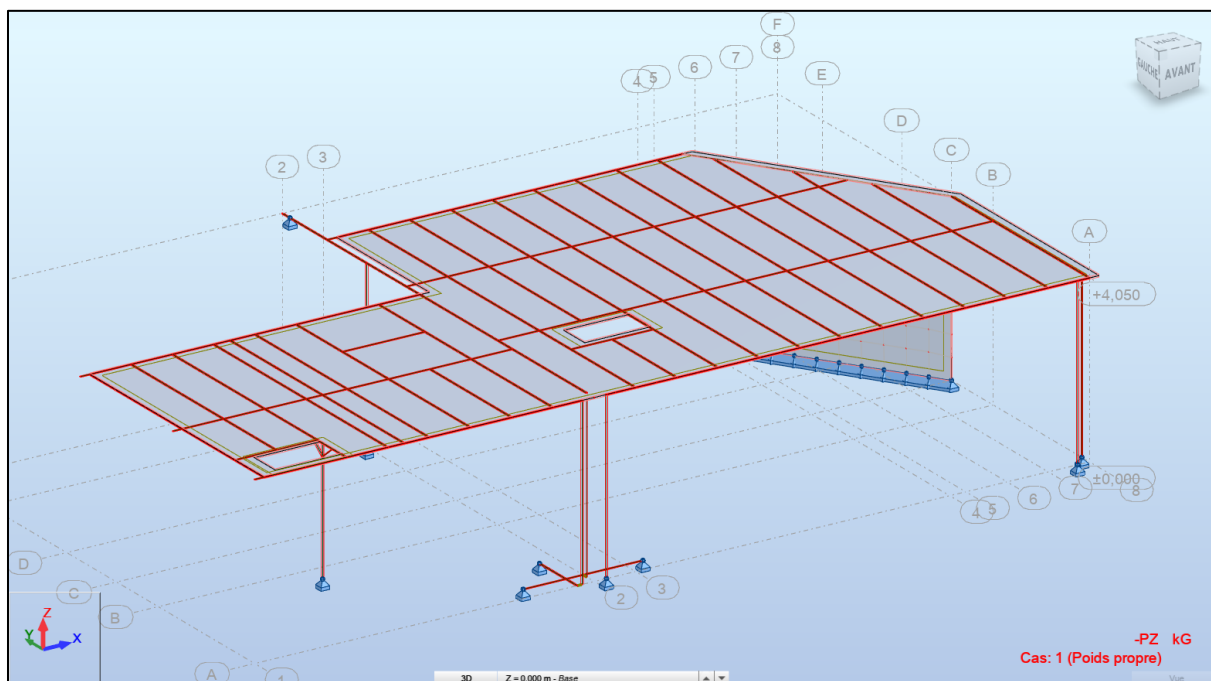


Figure 4-6 : Poids Propre

4.3.1.2. CAS DE CHARGE 2 – SURCHARGE PLANCHER

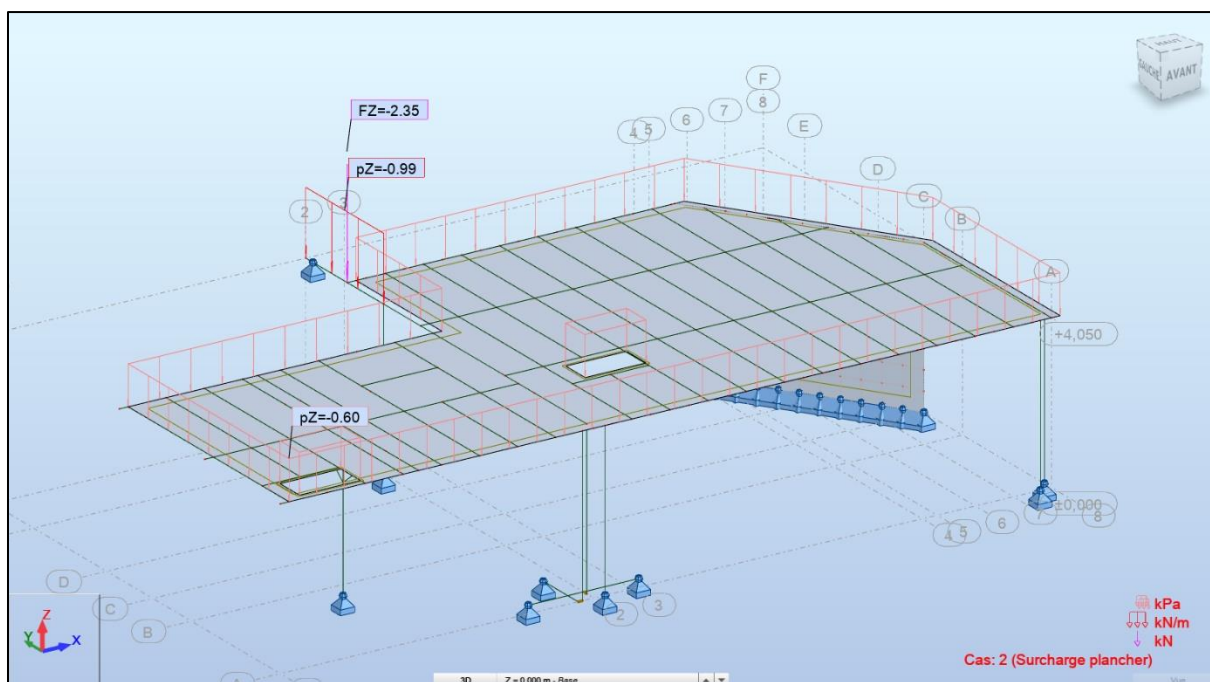


Figure 4-7 : Surcharge plancher

- La charge du réseau existant de 60 kg/m^2 ou de **$0,6 \text{ kN/m}^2$** .
- La valeur **$FZ = -2,35 \text{ kN}$** correspond au poids d'un IPE 160 non modélisé de la zone 1.

4.3.1.3. CAS DE CHARGE 8 – CHARGE D'EXPLOITATION HORIZONTALE – ELU

La somme des réactions d'appui en Fz à l'ELU est de -400,471 kN.

Ci-dessous, le calcul de la charge horizontale équivalente à appliquer en tête des poteaux.

Réactions globales		
ΣH	0	kN
ΣV	400,471	kN
$0,15 \times \Sigma V$	60,07065	kN
$\Sigma H < 0,15 \times \Sigma V$? OUI		
Effort horizontal équivalent		
h	4,05	m
m	1	-
ϕ	0,0050	-
ϕ_0	0,005	-
α_h	0,994	-
α_m	1,000	-
Nsd	400,471	kN
Heq	1,99	kN
S Bardage	165,00	m2
F horiz modèle	0,012	kN/m2

3- Calcul de l'imperfection géométrique globale:
Elles sont prises en compte lorsque la somme des efforts horizontaux est inférieure à 15% de la somme des efforts verticaux. Elles peuvent être remplacées par un système de forces équivalentes calculées pour chaque poteau.

$H_{eq} = \phi N_{sd}$

avec:
 H_{eq} : effort horizontal équivalent appliqué en tête de chaque poteau.
 N_{sd} : effort normal de compression dans le poteau.
 $\phi = \phi_0 \times \alpha_h \times \alpha_m$: défaut initial d'aplomb
 $\phi_0 = 1/200$: est la valeur de base.
 $\alpha_h = 2/\sqrt{h}$: est le coefficient de réduction qui tient compte de la hauteur h applicable au poteau.
 $\alpha_m = \sqrt{0.5(1+1/m)}$: est le coefficient de réduction qui tient compte du nombre de poteaux dans une rangée.

N_{sd}
 ϕ en radian
 H_{eq}

Figure 4-8 : Calcul de Q horizontale équivalente

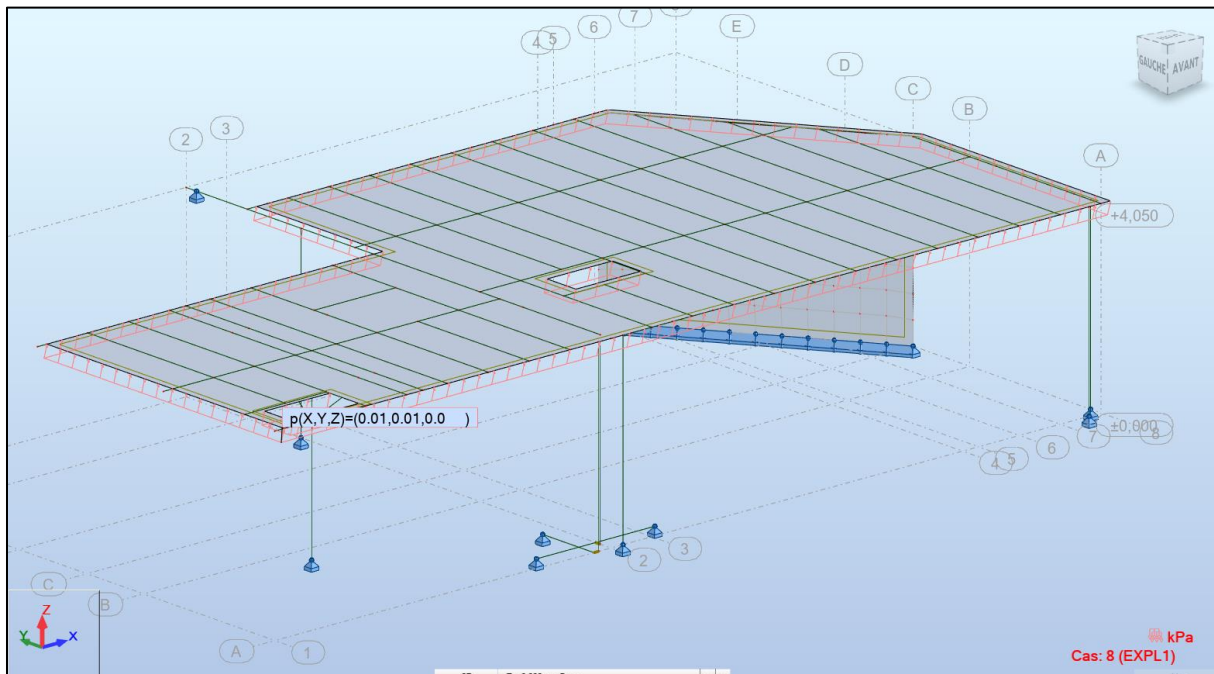


Figure 4-9 : Implémentation de la charge sur le modèle

La charge horizontale équivalente en ELU : $Q_{\text{horiz}}(X \text{ et } Y) = 0,012 \text{ kN/m}^2$.

4.3.1.4. CAS DE CHARGE 9 – CHARGE D'EXPLOITATION HORIZONTALE – ELS

La somme des réactions d'appui en Fz à l'ELS est de -296,65 kN.

Ci-dessous, le calcul de la charge horizontale équivalente à appliquer en tête des poteaux.

Réactions globales		
ΣH	0	kN
ΣV	296,646	kN
$0,15 \times \Sigma V$	44,4969	kN
$\Sigma H < 0,15 \times \Sigma V$? OUI		
Effort horizontal équivalent		
h	4,05	m
m	2	-
ϕ	0,0043	-
ϕ_0	0,005	-
α_h	0,994	-
α_m	0,866	-
Nsd	296,646	kN
Heq	1,28	kN
S Bardage	165,00	m2
F horiz modèle	0,008	kN/m2

3- Calcul de l'imperfection géométrique globale:
Elles sont prises en compte lorsque la somme des efforts horizontaux est inférieure à 15% de la somme des efforts verticaux. Elles peuvent être remplacées par un système de forces équivalentes calculées pour chaque poteau.

$H_{eq} = \phi N_{sd}$

avec:
 H_{eq} : effort horizontal équivalent appliqué en tête de chaque poteau.
 N_{sd} : effort normal de compression dans le poteau.
 $\phi = \phi_0 \times \alpha_h \times \alpha_m$: défaut initial d'aplomb
 $\phi_0 = 1/200$: est la valeur de base.
 $\alpha_h = 2/\sqrt{h}$: est le coefficient de réduction qui tient compte de la hauteur h applicable au poteau.
 $\alpha_m = \sqrt{0.5(1+1/m)}$: est le coefficient de réduction qui tient compte du nombre de poteaux dans une rangée.

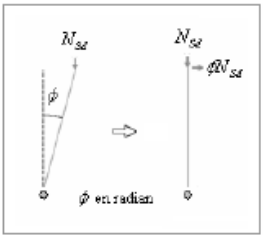


Figure 4-10 : Calcul de Q horizontale équivalente

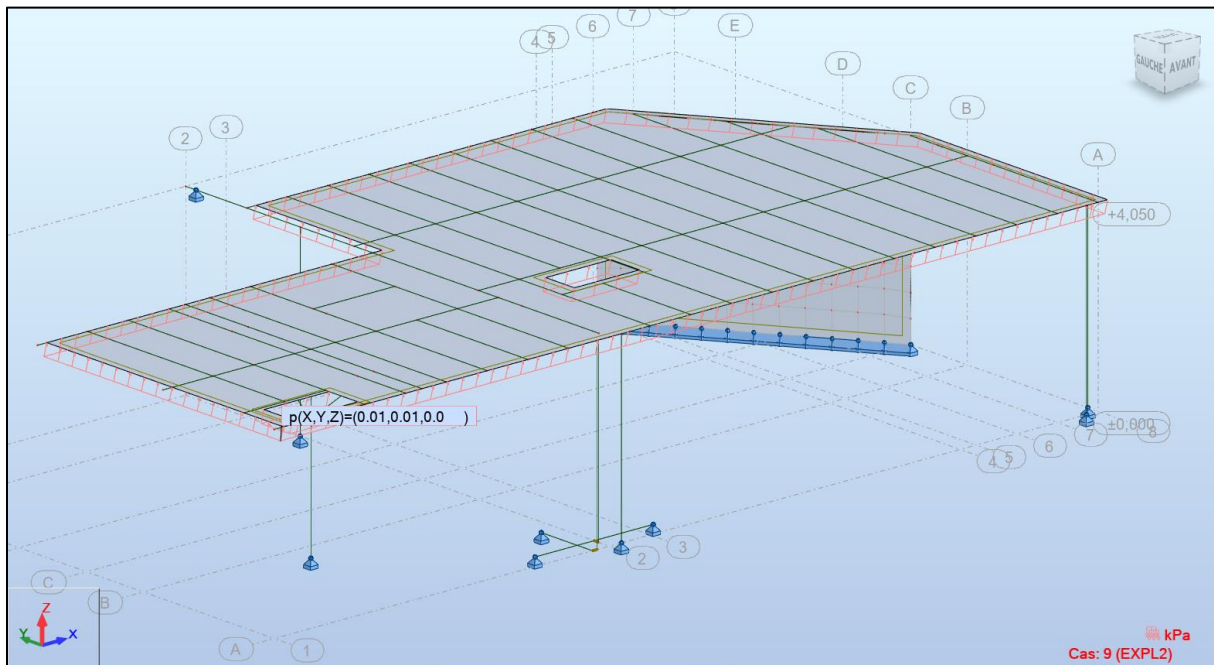


Figure 4-11 : Implémentation de la charge horizontale sur le modèle

La charge horizontale équivalente en ELS : $Q_{horiz}(X \text{ et } Y) = 0,008 \text{ kN/m}^2$.

4.3.2. COMBINAISONS DES CHARGES

Les combinaisons ELU et ELS des cas de charge, telles que générées par le logiciel, sont listées ci-dessous :

Combinaison	Nom	Cas	Coef.	Cas	Coef.
3 (C)	ELU/1=1*1.55 + 2*1.35	1	1,35	2	1,35
4 (C)	ELU/2=1*1.15 + 2*1.00	1	1,35	2	1,35
5 (C)	ELS:CAR/1=1*1.15 + 2*1.00	1	1	2	1
6 (C)	ELS:FRE/2=1*1.15 + 2*1.00	1	1	2	1
7 (C)	ELS:QPR/3=1*1.15 + 2*1.00	1	1	2	1
10 (C)	ELU Horiz	3	1	8	1
11 (C)	ELS Horiz	5	1	9	1

Tableau 4-1 : Combinaisons des chargements

4.4. JUSTIFICATION DES OUVRAGES

4.4.1. CHARPENTE MÉTALLIQUE

Les ratios des profilés sont indiqués en ANNEXE 1.

Les notes de vérifications des profilés sont indiquées en ANNEXE 2.

Tous les ratios sont inférieurs à 1 → OK.

5.CONCLUSION

La présente note de calcul complémentaire confirme la stabilité horizontale de la charpente métallique pour des poteaux de 4,05 m, en tenant compte de la charge de défaut d'aplomb. Les poteaux et l'ensemble des profilés sont dimensionnés correctement, et la structure existante, avec ses portiques jouant le rôle de contreventement (cf. NOTA §4.2), ne nécessite pas de contreventement supplémentaire, compte tenu de l'absence de charge de vent et de la faible charge verticale induisant des charges horizontales négligeables (de l'ordre de 200 kg aux ELU).

ANNEXE 1 RATIOS DES PROFILÉS

Pièce	Profil	Matériau	Lay	Laz	Ratio	Cas	Ratio(uy)	Cas (uy)	Ratio(uz)	Cas (uz)	Ratio(vx)	Cas (vx)	Ratio(vy)	Cas (vy)
1 Barre_1	TCAR 100x5	ACIER E24	62.78	62.78	0.15	10 ELU Horiz	-	-	-	-	-	-	-	-
2	HEA 340	ACIER E24	81.26	156.82	0.11	10 ELU Horiz	0.00	11 ELS Horiz	0.14	5 ELS:CAR/1=1*1.15	-	-	-	-
3	IPE 160	ACIER E24	55.49	197.94	0.08	10 ELU Horiz	0.01	11 ELS Horiz	0.07	5 ELS:CAR/1=1*1.15	-	-	-	-
6 Poteaux_14	UAP 300	ACIER E24	34.29	130.72	0.06	10 ELU Horiz	-	-	-	-	0.10	11 ELS Horiz	0.00	11 ELS Horiz
8	HEA 280	ACIER E24	66.92	113.39	0.07	3 ELU/1=1*1.55 + 2*	0.01	11 ELS Horiz	0.03	11 ELS Horiz	-	-	-	-
9	IPE 400	ACIER E24	31.60	132.40	0.21	10 ELU Horiz	0.08	11 ELS Horiz	0.06	5 ELS:CAR/1=1*1.15	-	-	-	-
10	HEA 400	ACIER E24	63.49	145.65	0.13	10 ELU Horiz	0.01	11 ELS Horiz	0.12	5 ELS:CAR/1=1*1.15	-	-	-	-
11	IPE 360	ACIER E24	57.57	227.31	0.09	10 ELU Horiz	0.00	11 ELS Horiz	0.08	11 ELS Horiz	-	-	-	-
13 Solives_13	IPE 160	ACIER	30.40	108.46	0.02	10 ELU Horiz	0.00	11 ELS Horiz	0.01	11 ELS Horiz	-	-	-	-
14 Poteaux_14	UAP 300	ACIER E24	34.29	130.72	0.19	10 ELU Horiz	-	-	-	-	0.04	11 ELS Horiz	0.00	11 ELS Horiz
15 Solives_15	IPE 160	ACIER E24	30.40	108.46	0.03	3 ELU/1=1*1.55 + 2*	0.00	5 ELS:CAR/1=1*1.15	0.01	5 ELS:CAR/1=1*1.15	-	-	-	-
16	IPE 160	ACIER E24	30.40	108.46	0.02	10 ELU Horiz	0.00	11 ELS Horiz	0.01	5 ELS:CAR/1=1*1.15	-	-	-	-
17	HEB 400	ACIER E24	70.27	162.25	0.14	3 ELU/1=1*1.55 + 2*	0.00	11 ELS Horiz	0.16	5 ELS:CAR/1=1*1.15	-	-	-	-
18 Poteaux_14	UAP 300	ACIER E24	34.29	130.72	0.24	3 ELU/1=1*1.55 + 2*	-	-	-	-	0.02	5 ELS:CAR/1=1*1.15	0.00	5 ELS:CAR/1=1*1.15
19	IPE 400	ACIER E24	19.34	81.01	0.07	10 ELU Horiz	0.05	11 ELS Horiz	0.01	11 ELS Horiz	-	-	-	-
20 Solives_20	IPE 160	ACIER E24	45.61	162.69	0.05	10 ELU Horiz	0.00	11 ELS Horiz	0.04	5 ELS:CAR/1=1*1.15	-	-	-	-
21 Poteaux U_21	UAP 300	ACIER E24	34.29	130.72	0.14	3 ELU/1=1*1.55 + 2*	-	-	-	-	0.04	11 ELS Horiz	0.21	11 ELS Horiz
25	IPE 160	ACIER E24	52.75	188.18	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
32	IPE 160	ACIER E24	52.75	188.18	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	11 ELS Horiz	-	-	-	-
33 Poutres_33	IPE 160	ACIER E24	37.25	132.87	0.03	10 ELU Horiz	0.00	11 ELS Horiz	0.02	11 ELS Horiz	-	-	-	-
34	IPE 160	ACIER E24	52.75	188.18	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
35 Solives_35	IPE 160	ACIER E24	55.49	197.94	0.08	10 ELU Horiz	0.01	11 ELS Horiz	0.07	11 ELS Horiz	-	-	-	-
36	IPE 160	ACIER E24	52.75	188.18	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
37 Solives_37	IPE 160	ACIER E24	55.49	197.94	0.06	10 ELU Horiz	0.01	11 ELS Horiz	0.05	11 ELS Horiz	-	-	-	-
38	IPE 160	ACIER E24	52.75	188.18	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
39 Solives_39	IPE 160	ACIER E24	55.49	197.94	0.06	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
40 Solives_40	IPE 160	ACIER E24	45.61	162.69	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	5 ELS:CAR/1=1*1.15	-	-	-	-
41 Solives_41	IPE 160	ACIER E24	45.61	162.69	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	5 ELS:CAR/1=1*1.15	-	-	-	-
42 Solives_42	IPE 160	ACIER E24	45.61	162.69	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	11 ELS Horiz	-	-	-	-
43 Solives_43	IPE 160	ACIER E24	45.61	162.69	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	11 ELS Horiz	-	-	-	-
44	IPE 160	ACIER E24	52.75	188.18	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
45 Solives_45	IPE 160	ACIER E24	45.61	162.69	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	11 ELS Horiz	-	-	-	-
46 Solives_46	IPE 160	ACIER E24	45.61	162.69	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	11 ELS Horiz	-	-	-	-
47 Solives_47	IPE 160	ACIER E24	37.05	132.18	0.02	10 ELU Horiz	0.00	11 ELS Horiz	0.01	5 ELS:CAR/1=1*1.15	-	-	-	-
48 Solives_48	IPE 160	ACIER E24	55.49	197.94	0.06	10 ELU Horiz	0.01	11 ELS Horiz	0.05	11 ELS Horiz	-	-	-	-
49	IPE 160	ACIER E24	52.75	188.18	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
50 Solives_50	IPE 160	ACIER E24	55.49	197.94	0.06	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
51 Solives_51	IPE 160	ACIER E24	47.13	168.12	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	5 ELS:CAR/1=1*1.15	-	-	-	-
52 Solives_52	IPE 160	ACIER E24	53.21	189.81	0.08	10 ELU Horiz	0.02	11 ELS Horiz	0.07	11 ELS Horiz	-	-	-	-
53 Solives_53	IPE 160	ACIER E24	47.13	168.12	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	5 ELS:CAR/1=1*1.15	-	-	-	-
55	IPE 160	ACIER E24	47.13	168.12	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	5 ELS:CAR/1=1*1.15	-	-	-	-
56	IPE 160	ACIER E24	53.21	189.81	0.08	10 ELU Horiz	0.02	11 ELS Horiz	0.07	5 ELS:CAR/1=1*1.15	-	-	-	-
57 Solives_57	IPE 160	ACIER E24	47.13	168.12	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	5 ELS:CAR/1=1*1.15	-	-	-	-
59	HEA 200	ACIER E24	37.43	62.24	0.25	10 ELU Horiz	0.00	5 ELS:CAR/1=1*1.15	0.11	11 ELS Horiz	-	-	-	-
61 Solives_61	IPE 160	ACIER E24	47.13	168.12	0.05	10 ELU Horiz	0.00	11 ELS Horiz	0.04	11 ELS Horiz	-	-	-	-
62 Solives_62	IPE 160	ACIER E24	53.21	189.81	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
64 Solives_64	IPE 160	ACIER E24	53.21	189.81	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
65	IPE 160	ACIER E24	52.75	188.18	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
67 Poteau HEA 2	HEA 200	ACIER E24	34.23	81.31	0.28	10 ELU Horiz	-	-	-	-	0.37	11 ELS Horiz	0.00	5 ELS:CAR/1=1*1.15
69 Solives_69	IPE 160	ACIER E24	55.49	197.94	0.06	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
73	HEA 240	ACIER E24	81.88	137.10	0.14	10 ELU Horiz	0.02	11 ELS Horiz	0.07	11 ELS Horiz	-	-	-	-
76 Solives_76	IPE 160	ACIER E24	55.49	197.94	0.06	10 ELU Horiz	0.01	11 ELS Horiz	0.05	11 ELS Horiz	-	-	-	-
78 Solives_78	IPE 160	ACIER E24	55.49	197.94	0.06	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
80 Solives_80	IPE 160	ACIER E24	55.49	197.94	0.06	10 ELU Horiz	0.01	11 ELS Horiz	0.05	11 ELS Horiz	-	-	-	-
97 Poteau HEA 2	HEA 200	ACIER E24	34.23	81.31	0.15	10 ELU Horiz	-	-	-	-	0.12	11 ELS Horiz	0.33	11 ELS Horiz
188 Solives_188	IPE 160	ACIER E24	47.13	168.12	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	5 ELS:CAR/1=1*1.15	-	-	-	-
189 Solives_189	IPE 160	ACIER E24	53.21	189.81	0.03	10 ELU Horiz	0.00	11 ELS Horiz	0.03	5 ELS:CAR/1=1*1.15	-	-	-	-
237 Solives_237	IPE 160	ACIER E24	45.61	162.69	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	11 ELS Horiz	-	-	-	-
241 Poutres_241	HEB 280	ACIER E24	67.95	116.16	0.11	10 ELU Horiz	0.02	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
257 Poutres_257	HEA 200	ACIER E24	42.26	70.27	0.34	3 ELU/1=1*1.55 + 2*	0.00	5 ELS:CAR/1=1*1.15	0.17	5 ELS:CAR/1=1*1.15	-	-	-	-
261 Solives_261	IPE 160	ACIER E24	53.21	189.81	0.05	10 ELU Horiz	0.00	11 ELS Horiz	0.04	5 ELS:CAR/1=1*1.15	-	-	-	-
262 Solives_262	IPE 160	ACIER E24	52.75	188.18	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
263 Solives_263	IPE 160	ACIER E24	45.95	163.91	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.03	11 ELS Horiz	-	-	-	-
264	IPE 160	ACIER E24	52.75	188.18	0.05	10 ELU Horiz	0.01	11 ELS Horiz	0.05	5 ELS:CAR/1=1*1.15	-	-	-	-
265 Solives_265	IPE 160	ACIER E24	15.13	53.96	0.03	10 ELU Horiz	0.00	11 ELS Horiz	0.00	5 ELS:CAR/1=1*1.15	-	-	-	-
266 Poteaux U_2	UAP 300	ACIER E24	34.29	130.72	0.02	3 ELU/1=1*1.55 + 2*	-	-	-	-	0.03	11 ELS Horiz	0.22	11 ELS Horiz
268 268	HEA 400	ACIER E24	49.44	113.43	0.18	10 ELU Horiz	0.01	11 ELS Horiz	0.11	11 ELS Horiz	-	-	-	-
269	TCAR 100x5	ACIER E24	57.11	57.11	0.15	3 ELU/1=1*1.55 + 2*	-	-	-	-	-	-	-	-
270	TCAR 100x5	ACIER E24	57.11	57.11	0.13	3 ELU/1=1*1.55 + 2*	-	-	-	-	-	-	-	-
271 Solives_271	IPE 160	ACIER E24	53.21	189.81	0.04	10 ELU Horiz	0.00	11 ELS Horiz	0.04	11 ELS Horiz	-	-	-	-
272 Solives_272	IPE 160	ACIER E24	47.13	168.12	0.03	10 ELU Horiz	0.00	11 ELS Horiz	0.02	5 ELS:CAR/1=1*1.15	-	-	-	-
276 Poutres_276	IPE 160	ACIER E24	30.40	108.46	0.04	10 ELU Horiz	0.01	11 ELS Horiz	0.00	5 ELS:CAR/1=1*1.15	-	-	-	-

ANNEXE 2 VÉRIFICATION DES PROFILÉS

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 1 Barre_1 **POINT:** 1 **COORDONNEE:** x = 0.00 L = 0.000 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: TCAR 100x5

h=10.0 cm $gM0=1.00$ $gM1=1.00$

b=10.0 cm $A_y=9.44$ cm² $A_z=9.44$ cm² $A_x=18.88$ cm²

tw=0.5 cm $I_y=282.80$ cm⁴ $I_z=282.80$ cm⁴ $I_x=438.80$ cm⁴

tf=0.5 cm $W_{ply}=67.75$ cm³ $W_{plz}=67.75$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 23.73$ kN $M_{y,Ed} = 0.87$ kN*m $M_{z,Ed} = -2.32$ kN*m $V_{y,Ed} = -0.79$ kN

$N_{c,Rd} = 443.68$ kN $M_{y,pl,Rd} = 15.92$ kN*m $M_{z,pl,Rd} = 15.92$ kN*m $V_{y,T,Rd} = 121.77$ kN

$N_{b,Rd} = 443.68 \text{ kN}$ $M_{y,c,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.71 \text{ kN}$

$M_{N,y,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $M_{N,z,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 121.77 \text{ kN}$

$T_{t,Ed} = -0.60 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.05 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.15 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{1.67} + (M_{z,Ed}/M_{N,z,Rd})^{1.67} = 0.05 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.01 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.01 < 1.00 \quad (6.2.6-7)$$

$$\tau_{y,Ed}/(\sigma_y/(\sqrt{3})\sigma_{M0}) = 0.05 < 1.00 \quad (6.2.6)$$

$$\tau_{z,Ed}/(\sigma_y/(\sqrt{3})\sigma_{M0}) = 0.05 < 1.00 \quad (6.2.6)$$

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 2 POINT: 3 COORDONNEE: $x = 0.50 L = 5.872 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 340

$h = 33.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 30.0 \text{ cm}$ $A_y = 110.39 \text{ cm}^2$ $A_z = 44.95 \text{ cm}^2$ $A_x = 133.47 \text{ cm}^2$

$t_w = 0.9 \text{ cm}$ $I_y = 27693.10 \text{ cm}^4$ $I_z = 7436.00 \text{ cm}^4$ $I_x = 127.71 \text{ cm}^4$

$t_f = 1.7 \text{ cm}$ $W_{ply} = 1850.48 \text{ cm}^3$ $W_{plz} = 755.95 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.82 \text{ kN}$ $M_{y,Ed} = 46.22 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.45 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = 0.31 \text{ kN}$

$N_{c,Rd} = 3136.55 \text{ kN}$ $M_{y,Ed,max} = 46.54 \text{ kN} \cdot \text{m}$ $M_{z,Ed,max} = 1.56 \text{ kN} \cdot \text{m}$
 $V_{y,c,Rd} = 1497.67 \text{ kN}$

$N_{b,Rd} = 832.28 \text{ kN}$ $M_{y,c,Rd} = 434.86 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 177.65 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = -2.04 \text{ kN}$

$$M_{N,y,Rd} = 434.86 \text{ kN}\cdot\text{m} \quad M_{N,z,Rd} = 177.65 \text{ kN}\cdot\text{m} \quad V_{z,c,Rd} = 609.84 \text{ kN}$$

$$M_{b,Rd} = 434.86 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$$z = 1.00 \quad M_{cr} = 25037.26 \text{ kN}\cdot\text{m} \quad \text{Courbe,LT} - X_{LT} = 1.00$$

$$L_{cr,upp} = 1.000 \text{ m} \quad \lambda_{m_LT} = 0.13 \quad f_{i,LT} = 0.48 \quad X_{LT,mod} = 1.00$$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$$L_y = 11.705 \text{ m} \quad \lambda_{m_y} = 0.87 \quad L_z = 11.705 \text{ m} \quad \lambda_{m_z} = 1.67$$

$$L_{cr,y} = 11.705 \text{ m} \quad X_y = 0.68 \quad L_{cr,z} = 11.705 \text{ m} \quad X_z = 0.27$$

$$\lambda_{my} = 81.26 \quad k_{yy} = 1.00 \quad \lambda_{mz} = 156.82 \quad k_{yz} = 0.70$$

flambement par torsion:

flambement en flexion-torsion

$$\text{Courbe,T} = c \quad \alpha_{f,T} = 0.49 \quad \text{Courbe,TF} = c \quad \alpha_{f,TF} = 0.49$$

$$L_t = 11.705 \text{ m} \quad f_{i,T} = 0.96 \quad N_{cr,y} = 4189.36 \text{ kN} \quad f_{i,TF} = 1.04$$

$$N_{cr,T} = 4969.25 \text{ kN} \quad X_{f,T} = 0.67 \quad N_{cr,TF} = 4189.36 \text{ kN} \quad X_{f,TF} = 0.62$$

$$\lambda_{m_T} = 0.79 \quad N_{b,T,Rd} = 2087.76 \text{ kN} \quad \lambda_{m_TF} = 0.87 \quad N_{b,TF,Rd} = 1948.76 \text{ kN}$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.11 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 81.26 < \lambda_{max} = 210.00 \quad \lambda_{z} = 156.82 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.11 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/\gamma_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/\gamma_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/\gamma_{M1}) = 0.11 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/\gamma_{M1}) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/\gamma_{M1}) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/\gamma_{M1}) = 0.06 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 5.9 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.8 \text{ cm} < u_{z \text{ max}} = L/200.00 = 5.9 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 3 POINT: 6 COORDONNEE: $x = 0.56 L = 2.042 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.00 \text{ kN}$ $M_{y,Ed} = 2.32 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.02 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = -0.00 \text{ kN}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{y,T,Rd} = 186.28 \text{ kN}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = 0.04 \text{ kN}$

$M_{N,y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{N,z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 131.01 \text{ kN}$

$T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.08 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\sigma_{yk}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_{yk}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 6 Poteaux_14 POINT: 7 COORDONNEE: $x = 1.00 \text{ L} = 4.050 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: UAP 300

$h = 30.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 10.0 \text{ cm}$ $A_y = 36.14 \text{ cm}^2$ $A_z = 30.64 \text{ cm}^2$ $A_x = 58.56 \text{ cm}^2$

$t_w = 0.9 \text{ cm}$ $I_y = 8170.18 \text{ cm}^4$ $I_z = 562.07 \text{ cm}^4$ $I_x = 38.46 \text{ cm}^4$

$t_f = 1.6 \text{ cm}$ $W_{ely} = 544.68 \text{ cm}^3$ $W_{elz} = 79.88 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 4.43 \text{ kN}$ $M_{y,Ed} = 3.77 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = 0.45 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = -0.02 \text{ kN}$

$N_{c,Rd} = 1376.13 \text{ kN}$ $M_{y,Ed,max} = 3.77 \text{ kN} \cdot \text{m}$ $M_{z,Ed,max} = 0.45 \text{ kN} \cdot \text{m}$
 $V_{y,T,Rd} = 489.14 \text{ kN}$

$N_{b,Rd} = 484.69 \text{ kN}$ $M_{y,c,Rd} = 128.00 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 18.77 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = 0.93 \text{ kN}$

$$V_{z,T,Rd} = 415.11 \text{ kN}$$

$$M_{b,Rd} = 87.04 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.02 \text{ kN}\cdot\text{m}$$

Classe de la section = 3



PARAMETRES DE DEVERSEMENT:

$$z = 0.00 \quad M_{cr} = 308.25 \text{ kN}\cdot\text{m} \quad \text{Courbe,LT} - d_{XLT} = 0.68$$

$$L_{cr,upp} = 4.050 \text{ m} \quad \lambda_{m,LT} = 0.64 \quad f_{t,LT} = 0.88$$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$$L_y = 4.050 \text{ m} \quad \lambda_{m,y} = 0.37 \quad L_z = 4.050 \text{ m} \quad \lambda_{m,z} = 1.39$$

$$L_{cr,y} = 4.050 \text{ m} \quad X_y = 0.92 \quad L_{cr,z} = 4.050 \text{ m} \quad X_z = 0.35$$

$$\lambda_{m,y} = 34.29 \quad k_{zy} = 1.00 \quad \lambda_{m,z} = 130.72 \quad k_{zz} = 1.00$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} + M_{y,Ed}/M_{y,c,Rd} + M_{z,Ed}/M_{z,c,Rd} = 0.05 < 1.00 \quad (6.2.1(7))$$

$$\sqrt{(\sigma_{x,Ed})^2 + 3 \cdot (\tau_{z,Ed} + \tau_{tz,Ed})^2} / (f_y / \gamma_{M0}) = 0.05 < 1.00 \quad (6.2.1.(5))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{t,y,Ed} / (f_y / (\sqrt{3} \cdot \gamma_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed} / (f_y / (\sqrt{3} \cdot \gamma_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{m,y} = 34.29 < \lambda_{m,max} = 210.00 \quad \lambda_{m,z} = 130.72 < \lambda_{m,max} = 210.00 \quad \text{STABLE}$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.04 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed} / (X_y \cdot N_{Rk} / \gamma_{M1}) + k_{yy} \cdot M_{y,Ed,max} / (X_{LT} \cdot M_{y,Rk} / \gamma_{M1}) + k_{yz} \cdot M_{z,Ed,max} / (M_{z,Rk} / \gamma_{M1}) = 0.06 < 1.00 \quad (6.3.3.(4))$$

$$\frac{N_{Ed}}{(X_z \cdot N_{Rk/gM1})} + \frac{k_{zy} \cdot M_{y,Ed,max}}{(X_{LT} \cdot M_{y,Rk/gM1})} + \frac{k_{zz} \cdot M_{z,Ed,max}}{(M_{z,Rk/gM1})} = 0.06 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$$v_x = 0.3 \text{ cm} < v_{x \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$v_y = 0.0 \text{ cm} < v_{y \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 8 **POINT:** 7 **COORDONNEE:** x = 0.46 L = 3.630 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: HEA 280** $h=27.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$ $b=28.0 \text{ cm}$ $A_y=81.58 \text{ cm}^2$ $A_z=31.74 \text{ cm}^2$ $A_x=97.26 \text{ cm}^2$ $t_w=0.8 \text{ cm}$ $I_y=13673.30 \text{ cm}^4$ $I_z=4762.64 \text{ cm}^4$ $I_x=62.37 \text{ cm}^4$ $t_f=1.3 \text{ cm}$ $W_{ply}=1112.22 \text{ cm}^3$ $W_{plz}=518.13 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $M_{y,Ed} = -15.23 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -1.84 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 4.96 \text{ kN}$ $M_{y,pl,Rd} = 261.37 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 121.76 \text{ kN}\cdot\text{m}$ $V_{y,c,Rd} = 1106.86 \text{ kN}$ $M_{y,c,Rd} = 261.37 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 121.76 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -8.48 \text{ kN}$ $V_{z,c,Rd} = 430.64 \text{ kN}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:** $M_{y,Ed}/M_{y,c,Rd} = 0.06 < 1.00 \text{ (6.2.5.(1))}$ $M_{z,Ed}/M_{z,c,Rd} = 0.02 < 1.00 \text{ (6.2.5.(1))}$

$$(M_{y,Ed}/M_{N,y,Rd})^2 + (M_{z,Ed}/M_{N,z,Rd})^1 = 0.02 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.02 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$M_{y,Ed}/(XLT \cdot M_{y,Rk}/gM1) + M_{z,Ed}/(M_{z,Rk}/gM1) = 0.07 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 4.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 4.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 9 **POINT:** 7 **COORDONNEE:** x = 0.70 L = 3.650 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 400

$h = 40.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 18.0 \text{ cm}$ $A_y = 55.99 \text{ cm}^2$ $A_z = 42.69 \text{ cm}^2$ $A_x = 84.46 \text{ cm}^2$

$t_w = 0.9 \text{ cm}$ $I_y = 23128.40 \text{ cm}^4$ $I_z = 1317.82 \text{ cm}^4$ $I_x = 51.33 \text{ cm}^4$

$t_f = 1.4 \text{ cm}$ $W_{ply} = 1307.15 \text{ cm}^3$ $W_{plz} = 229.00 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 1.62 \text{ kN}$ $M_{y,Ed} = 43.23 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = 3.39 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = -0.94 \text{ kN}$

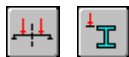
$N_{c,Rd} = 1984.81 \text{ kN}$ $M_{y,Ed,max} = 43.23 \text{ kN} \cdot \text{m}$ $M_{z,Ed,max} = 3.39 \text{ kN} \cdot \text{m}$
 $V_{y,c,Rd} = 759.71 \text{ kN}$

$N_{b,Rd} = 749.39 \text{ kN}$ $M_{y,c,Rd} = 307.18 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 53.82 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = 6.51 \text{ kN}$

$MN_{y,Rd} = 307.18 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 53.82 \text{ kN} \cdot \text{m}$ $V_{z,c,Rd} = 579.22 \text{ kN}$

$M_{b,Rd} = 266.42 \text{ kN} \cdot \text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 769.76 \text{ kN} \cdot \text{m}$ Courbe,LT - $X_{LT} = 0.83$

$L_{cr,upp} = 3.360 \text{ m}$ $\lambda_{m,LT} = 0.63$ $f_{i,LT} = 0.77$ $X_{LT,mod} = 0.87$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$$L_y = 5.230 \text{ m} \quad \text{Lam}_y = 0.34 \quad L_z = 5.230 \text{ m} \quad \text{Lam}_z = 1.41$$

$$\text{Lcr}_y = 5.230 \text{ m} \quad X_y = 0.97 \quad \text{Lcr}_z = 5.230 \text{ m} \quad X_z = 0.38$$

$$\text{Lam}_y = 31.60 \quad k_{yy} = 1.00 \quad \text{Lam}_z = 132.40 \quad k_{yz} = 0.73$$

flambement par torsion: flambement en flexion-torsion

$$\text{Courbe}_T = b \quad \alpha_T = 0.34 \quad \text{Courbe}_{TF} = b \quad \alpha_{TF} = 0.34$$

$$L_t = 5.230 \text{ m} \quad f_{iT} = 0.98 \quad N_{cr,y} = 17525.13 \text{ kN} \quad f_{iT,TF} = 0.58$$

$$N_{cr,T} = 2720.77 \text{ kN} \quad X_T = 0.69 \quad N_{cr,TF} = 17525.13 \text{ kN} \quad X_{TF} = 0.95$$

$$\text{Lam}_T = 0.85 \quad N_{b,T,Rd} = 1370.58 \text{ kN} \quad \text{Lam}_{TF} = 0.34 \quad N_{b,TF,Rd} = 1886.66 \text{ kN}$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.14 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.06 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.08 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.01 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\text{Lambda}_y = 31.60 < \text{Lambda}_{\max} = 210.00 \quad \text{Lambda}_z = 132.40 < \text{Lambda}_{\max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\text{Min}(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,\max}/M_{b,Rd} = 0.16 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yy} \cdot M_{y,Ed,\max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{yz} \cdot M_{z,Ed,\max}/(M_{z,Rk}/gM1) = 0.21 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/gM1) + k_{zy} \cdot M_{y,Ed,\max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{zz} \cdot M_{z,Ed,\max}/(M_{z,Rk}/gM1) = 0.15 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES

**Flèches (REPERE LOCAL):**

$$u_y = 0.2 \text{ cm} < u_y \text{ max} = L/200.00 = 2.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.2 \text{ cm} < u_z \text{ max} = L/200.00 = 2.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 10 **POINT:** 4 **COORDONNEE:** $x = 0.51 L = 5.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: HEA 400**

$h=39.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$
 $b=30.0\text{ cm}$ $A_y=126.20\text{ cm}^2$ $A_z=57.33\text{ cm}^2$ $A_x=158.98\text{ cm}^2$
 $t_w=1.1\text{ cm}$ $I_y=45069.40\text{ cm}^4$ $I_z=8563.83\text{ cm}^4$ $I_x=189.76\text{ cm}^4$
 $t_f=1.9\text{ cm}$ $W_{ply}=2561.80\text{ cm}^3$ $W_{plz}=872.86\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 6.54\text{ kN}$ $M_{y,Ed} = 71.52\text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.37\text{ kN}\cdot\text{m}$ $V_{y,Ed} = 0.13\text{ kN}$

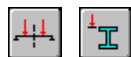
$N_{c,Rd} = 3736.03\text{ kN}$ $M_{y,Ed,max} = 71.77\text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = -1.70\text{ kN}\cdot\text{m}$
 $V_{y,T,Rd} = 1710.44\text{ kN}$

$N_{b,Rd} = 1211.09\text{ kN}$ $M_{y,c,Rd} = 602.02\text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 205.12\text{ kN}\cdot\text{m}$
 $V_{z,Ed} = -0.93\text{ kN}$

$MN_{y,Rd} = 602.02\text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 205.12\text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 777.36\text{ kN}$

$Mb_{Rd} = 602.02\text{ kN}\cdot\text{m}$ $Tt_{Ed} = 0.04\text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 33422.54\text{ kN}\cdot\text{m}$ Courbe,LT - $X_{LT} = 1.00$
 $L_{cr,upp}=1.000\text{ m}$ $Lam_{LT} = 0.13$ $f_{i,LT} = 0.48$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 10.690\text{ m}$ $Lam_y = 0.68$ $L_z = 10.690\text{ m}$ $Lam_z = 1.55$
 $L_{cr,y} = 10.690\text{ m}$ $X_y = 0.86$ $L_{cr,z} = 10.690\text{ m}$ $X_z = 0.32$
 $Lam_y = 63.49$ $k_{yy} = 1.00$ $Lam_z = 145.65$ $k_{yz} = 0.70$

flambement par torsion: flambement en flexion-torsion

Courbe,T=b $\alpha_{T,b}=0.34$ Courbe,TF=b $\alpha_{TF,b}=0.34$

$$L_t = 10.690 \text{ m} \quad f_{t,T} = 0.90 \quad N_{cr,y} = 8174.58 \text{ kN} \quad f_{t,TF} = 0.81$$

$$N_{cr,T} = 6127.51 \text{ kN} \quad X_{T,T} = 0.74 \quad N_{cr,TF} = 8174.58 \text{ kN} \quad X_{TF,T} = 0.80$$

$$L_{am_T} = 0.78 \quad N_{b,T,Rd} = 2750.46 \text{ kN} \quad L_{am_TF} = 0.68 \quad N_{b,TF,Rd} = 2977.86 \text{ kN}$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.12 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.02 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 63.49 < \lambda_{max} = 210.00 \quad \lambda_{z} = 145.65 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.01 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.12 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/g_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.13 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/g_{M1}) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.08 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y,max} = L/200.00 = 5.3 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 11 \text{ ELS Horiz } (5+9) \cdot 1.00$$

$$u_z = 0.7 \text{ cm} < u_{z,max} = L/200.00 = 5.3 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 11 **POINT:** 1 **COORDONNEE:** x = 0.54 L = 4.610 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: IPE 360

h=36.0 cm $g_{M0}=1.00$ $g_{M1}=1.00$

b=17.0 cm $A_y=48.84$ cm² $A_z=35.14$ cm² $A_x=72.73$ cm²

tw=0.8 cm $I_y=16265.60$ cm⁴ $I_z=1043.45$ cm⁴ $I_x=37.49$ cm⁴

tf=1.3 cm $W_{ply}=1019.15$ cm³ $W_{plz}=191.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -5.41 \text{ kN}$ $M_{y,Ed} = 21.81 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = 0.02 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 0.01 \text{ kN}$
 $N_{t,Rd} = 1709.16 \text{ kN}$ $M_{y,pl,Rd} = 239.50 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 44.91 \text{ kN}\cdot\text{m}$
 $V_{y,T,Rd} = 662.62 \text{ kN}$
 $M_{y,c,Rd} = 239.50 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 44.91 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -1.47 \text{ kN}$
 $MN_{y,Rd} = 239.50 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 44.91 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 476.72 \text{ kN}$
 $Mb,Rd = 239.50 \text{ kN}\cdot\text{m}$ $Tt,Ed = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

$z = 1.00$ $M_{cr} = 3987.75 \text{ kN}\cdot\text{m}$ Courbe,LT - $X_{LT} = 1.00$
 $L_{cr,upp} = 1.000 \text{ m}$ $\lambda_{m,LT} = 0.25$ $f_{i,LT} = 0.53$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$N_{Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))
 $M_{y,Ed}/MN_{y,Rd} = 0.09 < 1.00$ (6.2.9.1.(2))
 $M_{z,Ed}/MN_{z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))
 $(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.01 < 1.00$ (6.2.9.1.(6))
 $V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00$ (6.2.6-7)
 $V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00$ (6.2.6-7)
 $\tau_{ty,Ed}/(f_y/(\sqrt{3})\cdot gM0) = 0.00 < 1.00$ (6.2.6)

$$\tau_{u,tz,Ed}/(f_y/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$M_{y,Ed}/M_{b,Rd} = 0.09 < 1.00 \quad (6.3.2.1.(1))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 4.3 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.4 \text{ cm} < u_{z \text{ max}} = L/200.00 = 4.3 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 13 Solives_13 **POINT:** 7 **COORDONNEE:** x = 0.50 L = 1.000 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -0.01 \text{ kN}$ $M_{y,Ed} = 0.62 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.00 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = 0.00 \text{ kN}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{y,T,Rd} = 186.23 \text{ kN}$

$M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = 0.52 \text{ kN}$

$MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 130.99 \text{ kN}$

$T_{t,Ed} = -0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.02 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^2 + (M_{z,Ed}/M_{N,z,Rd})^1 = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\sigma_{yk}/\sqrt{3}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_{yk}/\sqrt{3}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 14 Poteaux_14 POINT: 6 COORDONNEE: $x = 0.83 L = 3.375 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: UAP 300

$h = 30.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 10.0 \text{ cm}$ $A_y = 36.14 \text{ cm}^2$ $A_z = 30.64 \text{ cm}^2$ $A_x = 58.56 \text{ cm}^2$

$t_w = 0.9 \text{ cm}$ $I_y = 8170.18 \text{ cm}^4$ $I_z = 562.07 \text{ cm}^4$ $I_x = 38.46 \text{ cm}^4$

$t_f = 1.6 \text{ cm}$ $W_{ey} = 544.68 \text{ cm}^3$ $W_{ez} = 79.88 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 19.96 \text{ kN}$ $M_{z,Ed} = -0.48 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = -0.72 \text{ kN}$

$N_{c,Rd} = 1376.13 \text{ kN}$ $M_{z,Ed,max} = -2.90 \text{ kN} \cdot \text{m}$ $V_{y,c,Rd} = 490.32 \text{ kN}$

$N_{b,Rd} = 484.69 \text{ kN}$ $M_{z,c,Rd} = 18.77 \text{ kN} \cdot \text{m}$

Classe de la section = 3



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$$L_y = 4.050 \text{ m} \quad \text{Lam}_y = 0.37 \quad L_z = 4.050 \text{ m} \quad \text{Lam}_z = 1.39$$

$$\text{Lcr}_y = 4.050 \text{ m} \quad X_y = 0.92 \quad \text{Lcr}_z = 4.050 \text{ m} \quad X_z = 0.35$$

$$\text{Lamy} = 34.29 \quad k_{yz} = 1.00 \quad \text{Lamz} = 130.72 \quad k_{zz} = 0.98$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$M_{z,Ed}/M_{z,c,Rd} = 0.03 < 1.00 \quad (6.2.5.(1))$$

$$N_{Ed}/N_{c,Rd} + M_{z,Ed}/M_{z,c,Rd} = 0.04 < 1.00 \quad (6.2.1(7))$$

$$\sqrt{(\text{Sig}_{x,Ed}^2 + 3 \cdot \text{Tau}_{y,Ed}^2)} / (f_y / \gamma_{M0}) = 0.04 < 1.00 \quad (6.2.1.(5))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\text{Lambda}_y = 34.29 < \text{Lambda}_{\text{max}} = 210.00 \quad \text{Lambda}_z = 130.72 < \text{Lambda}_{\text{max}} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/(X_y \cdot N_{Rk}/\gamma_{M1}) + k_{yz} \cdot M_{z,Ed,\text{max}}/(M_{z,Rk}/\gamma_{M1}) = 0.17 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/\gamma_{M1}) + k_{zz} \cdot M_{z,Ed,\text{max}}/(M_{z,Rk}/\gamma_{M1}) = 0.19 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$$v_x = 0.1 \text{ cm} < v_{x \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$v_y = 0.0 \text{ cm} < v_{y \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 15 Solives_15 POINT: 1 COORDONNEE: $x = 0.50 L = 1.000 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 (1+2) \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -0.00 \text{ kN}$ $M_{y,Ed} = 0.74 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.00 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = -0.00 \text{ kN}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{y,T,Rd} = 186.28 \text{ kN}$

$M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = -0.63 \text{ kN}$

$MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 131.01 \text{ kN}$

$$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.03 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3}\cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3}\cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 16 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.000 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = 0.01 \text{ kN} \quad M_{y,Ed} = 0.51 \text{ kN}\cdot\text{m} \quad M_{z,Ed} = -0.00 \text{ kN}\cdot\text{m}$$

$$N_{c,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$N_{b,Rd} = 472.12 \text{ kN} \quad M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{N,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.02 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{t,y,Ed}/(\tau_y/(\sqrt{3} \cdot gM_0)) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(\tau_y/(\sqrt{3} \cdot gM_0)) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \max} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$uz = 0.0 \text{ cm} < uz_{\text{max}} = L/200.00 = 1.0 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 17 **POINT:** 7 **COORDONNEE:** $x = 0.50 L = 6.000 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEB 400

$h=40.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=30.0 \text{ cm}$ $A_y=157.55 \text{ cm}^2$ $A_z=69.98 \text{ cm}^2$ $A_x=197.78 \text{ cm}^2$

$tw=1.4 \text{ cm}$ $I_y=57680.50 \text{ cm}^4$ $I_z=10819.00 \text{ cm}^4$ $I_x=357.00 \text{ cm}^4$

$t_f=2.4$ cm $W_{ply}=3231.74$ cm³ $W_{plz}=1104.04$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -2.08$ kN $M_{y,Ed} = 103.77$ kN*m $M_{z,Ed} = -0.22$ kN*m $V_{y,Ed} = 0.03$ kN

$N_{t,Rd} = 4647.83$ kN $M_{y,pl,Rd} = 759.46$ kN*m $M_{z,pl,Rd} = 259.45$ kN*m
 $V_{y,T,Rd} = 2136.34$ kN

$M_{y,c,Rd} = 759.46$ kN*m $M_{z,c,Rd} = 259.45$ kN*m $V_{z,Ed} = 1.96$ kN

$MN_{y,Rd} = 759.46$ kN*m $MN_{z,Rd} = 259.45$ kN*m $V_{z,T,Rd} = 949.16$ kN

$Mb,Rd = 759.46$ kN*m $T_{t,Ed} = -0.03$ kN*m

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

$z = 1.00$ $M_{cr} = 43404.77$ kN*m Courbe,LT - $X_{LT} = 1.00$

$L_{cr,upp}=1.000$ m $\lambda_{m_LT} = 0.13$ $f_{i,LT} = 0.48$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$N_{Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.14 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.02 < 1.00$ (6.2.9.1.(6))

$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\sigma_{y,Rd}/\sqrt{3}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_{x,Rd}/\sqrt{3}) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$M_{y,Ed}/M_{b,Rd} = 0.14 < 1.00 \quad (6.3.2.1.(1))$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 6.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.9 \text{ cm} < u_{z \text{ max}} = L/200.00 = 6.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

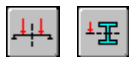
NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:**PIECE:** 18 Poteaux_14 **POINT:** 7 **COORDONNEE:** x = 1.00 L = 4.050 m

CHARGEMENTS:**Cas de charge décisif:** 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: UAP 300** $h = 30.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$ $b = 10.0 \text{ cm}$ $A_y = 36.14 \text{ cm}^2$ $A_z = 30.64 \text{ cm}^2$ $A_x = 58.56 \text{ cm}^2$ $t_w = 0.9 \text{ cm}$ $I_y = 8170.18 \text{ cm}^4$ $I_z = 562.07 \text{ cm}^4$ $I_x = 38.46 \text{ cm}^4$ $t_f = 1.6 \text{ cm}$ $W_{ey} = 544.68 \text{ cm}^3$ $W_{ez} = 79.88 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{Ed} = 36.24 \text{ kN}$ $M_{y,Ed} = -2.38 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = 1.01 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.89 \text{ kN}$ $N_{c,Rd} = 1376.13 \text{ kN}$ $M_{y,Ed,max} = -2.38 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = -2.59 \text{ kN}\cdot\text{m}$
 $V_{y,T,Rd} = 489.94 \text{ kN}$ $N_{b,Rd} = 484.69 \text{ kN}$ $M_{y,c,Rd} = 128.00 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 18.77 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.61 \text{ kN}$ $V_{z,T,Rd} = 415.51 \text{ kN}$ $M_{b,Rd} = 87.69 \text{ kN}\cdot\text{m}$ $T_{t,Ed} = 0.01 \text{ kN}\cdot\text{m}$

Classe de la section = 3

**PARAMETRES DE DEVERSEMENT:** $z = 0.00$ $M_{cr} = 315.59 \text{ kN}\cdot\text{m}$ Courbe,LT - dXLT = 0.69 $L_{cr,low} = 4.050 \text{ m}$ $\lambda_{m,LT} = 0.64$ $f_{l,LT} = 0.87$ 

en y:



en z:

$$L_y = 4.050 \text{ m} \quad L_{m,y} = 0.37 \quad L_z = 4.050 \text{ m} \quad L_{m,z} = 1.39$$

$$L_{cr,y} = 4.050 \text{ m} \quad X_y = 0.92 \quad L_{cr,z} = 4.050 \text{ m} \quad X_z = 0.35$$

$$L_{m,y} = 34.29 \quad k_{zy} = 0.99 \quad L_{m,z} = 130.72 \quad k_{zz} = 0.97$$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} + M_{y,Ed}/M_{y,c,Rd} + M_{z,Ed}/M_{z,c,Rd} = 0.07 < 1.00 \quad (6.2.1(7))$$

$$\sqrt{(\sigma_{x,Ed})^2 + 3 \cdot (\tau_{xy,Ed})^2} / (f_y / g_{M0}) = 0.07 < 1.00 \quad (6.2.1(5))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed} / (f_y / (\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed} / (f_y / (\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 34.29 < \lambda_{y,max} = 210.00 \quad \lambda_{z} = 130.72 < \lambda_{z,max} = 210.00 \quad \text{STABLE}$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.03 < 1.00 \quad (6.3.2.1(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/g_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.19 < 1.00 \quad (6.3.3(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/g_{M1}) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.24 < 1.00 \quad (6.3.3(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$$v_x = 0.1 \text{ cm} < v_{x,max} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$$v_y = 0.0 \text{ cm} < v_{y,max} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 19 **POINT:** 1 **COORDONNEE:** $x = 0.47 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 400

$h=40.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=18.0 \text{ cm}$ $A_y=55.99 \text{ cm}^2$ $A_z=42.69 \text{ cm}^2$ $A_x=84.46 \text{ cm}^2$

$t_w=0.9 \text{ cm}$ $I_y=23128.40 \text{ cm}^4$ $I_z=1317.82 \text{ cm}^4$ $I_x=51.33 \text{ cm}^4$

$t_f=1.4 \text{ cm}$ $W_{ply}=1307.15 \text{ cm}^3$ $W_{plz}=229.00 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -3.92 \text{ kN}$ $M_{y,Ed} = 11.59 \text{ kN}^*\text{m}$ $M_{z,Ed} = -3.96 \text{ kN}^*\text{m}$ $V_{y,Ed} = -2.82 \text{ kN}$

$N_{t,Rd} = 1984.81 \text{ kN}$ $M_{y,pl,Rd} = 307.18 \text{ kN}^*\text{m}$ $M_{z,pl,Rd} = 53.82 \text{ kN}^*\text{m}$
 $V_{y,c,Rd} = 759.71 \text{ kN}$

$M_{y,c,Rd} = 307.18 \text{ kN}^*\text{m}$ $M_{z,c,Rd} = 53.82 \text{ kN}^*\text{m}$ $V_{z,Ed} = -6.74 \text{ kN}$

$MN_{y,Rd} = 307.18 \text{ kN}^*\text{m}$ $MN_{z,Rd} = 53.82 \text{ kN}^*\text{m}$ $V_{z,c,Rd} = 579.22 \text{ kN}$

$Mb,Rd = 304.88 \text{ kN}^*\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 2995.85 \text{ kN}^*\text{m}$ Courbe,LT - $X_{LT} = 0.97$

$L_{cr,upp} = 1.700 \text{ m}$ $\lambda_{m,LT} = 0.32$ $f_{t,LT} = 0.57$ $X_{LT,mod} = 0.99$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.04 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.07 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.07 < 1.00$ (6.2.9.1.(6))

$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00$ (6.2.6.(1))

$V_{z,Ed}/V_{z,c,Rd} = 0.01 < 1.00$ (6.2.6.(1))

Contrôle de la stabilité globale de la barre:

$M_{y,Ed}/Mb,Rd = 0.04 < 1.00$ (6.3.2.1.(1))

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.1 \text{ cm} < u_y \text{ max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_z \text{ max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 20 Solives_20 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$
 $b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$
 $t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$
 $t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.08\text{ kN}$ $M_{y,Ed} = 1.40\text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.01\text{ kN}\cdot\text{m}$
 $N_{t,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13\text{ kN}\cdot\text{m}$
 $M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13\text{ kN}\cdot\text{m}$
 $MN_{y,Rd} = 29.11\text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13\text{ kN}\cdot\text{m}$
 $T_{t,Ed} = 0.00\text{ kN}\cdot\text{m}$
 Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{,Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))
 $M_{y,Ed}/MN_{y,Rd} = 0.05 < 1.00$ (6.2.9.1.(2))

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^2 + (M_{z,Ed}/M_{N,z,Rd})^1 = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 21 Poteaux U_21 **POINT:** 7 **COORDONNEE:** x = 1.00 L = 4.050 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$


PARAMETRES DE LA SECTION: UAP 300
 $h = 30.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$
 $b = 10.0 \text{ cm}$ $A_y = 36.14 \text{ cm}^2$ $A_z = 30.64 \text{ cm}^2$ $A_x = 58.56 \text{ cm}^2$
 $t_w = 0.9 \text{ cm}$ $I_y = 8170.18 \text{ cm}^4$ $I_z = 562.07 \text{ cm}^4$ $I_x = 38.46 \text{ cm}^4$
 $t_f = 1.6 \text{ cm}$ $W_{ply} = 639.34 \text{ cm}^3$ $W_{plz} = 144.83 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:
 $N_{Ed} = 67.20 \text{ kN}$
 $N_{c,Rd} = 1376.13 \text{ kN}$
 $N_{b,Rd} = 484.69 \text{ kN}$

Classe de la section = 1


PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:


en y:



en z:

 $L_y = 4.050 \text{ m}$ $\lambda_{m,y} = 0.37$ $L_z = 4.050 \text{ m}$ $\lambda_{m,z} = 1.39$
 $L_{cr,y} = 4.050 \text{ m}$ $X_y = 0.92$ $L_{cr,z} = 4.050 \text{ m}$ $X_z = 0.35$
 $\lambda_{m,y} = 34.29$ $\lambda_{m,z} = 130.72$

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.05 < 1.00 \quad (6.2.4.(1))$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 34.29 < \lambda_{max} = 210.00 \quad \lambda_{z} = 130.72 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/N_{b,Rd} = 0.14 < 1.00 \quad (6.3.1.1.(1))$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):** Non analysé**Déplacements (REPERE GLOBAL):**

$$v_x = 0.1 \text{ cm} < v_{x \max} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$v_y = 0.6 \text{ cm} < v_{y \max} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00**Profil correct !!!****CALCUL DES STRUCTURES ACIER****NORME:** NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces**FAMILLE:****PIECE:** 25 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.735 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0$ cm $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2$ cm $A_y = 13.73$ cm² $A_z = 9.66$ cm² $A_x = 20.09$ cm²

$t_w = 0.5$ cm $I_y = 869.29$ cm⁴ $I_z = 68.31$ cm⁴ $I_x = 3.62$ cm⁴

$t_f = 0.7$ cm $W_{ply} = 123.86$ cm³ $W_{plz} = 26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -0.07$ kN $M_{y,Ed} = 1.56$ kN*m $M_{z,Ed} = -0.02$ kN*m $V_{y,Ed} = 0.00$ kN

$N_{t,Rd} = 472.12$ kN $M_{y,pl,Rd} = 29.11$ kN*m $M_{z,pl,Rd} = 6.13$ kN*m $V_{y,T,Rd} = 186.22$ kN

$M_{y,c,Rd} = 29.11$ kN*m $M_{z,c,Rd} = 6.13$ kN*m $V_{z,Ed} = 0.01$ kN

$MN_{y,Rd} = 29.11$ kN*m $MN_{z,Rd} = 6.13$ kN*m $V_{z,T,Rd} = 130.98$ kN

$T_{t,Ed} = 0.00$ kN*m

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\tau_{xy}/(\sqrt{3} \cdot \sigma_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\tau_{xz}/(\sqrt{3} \cdot \sigma_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces**FAMILLE:****PIECE:** 32 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.735 \text{ m}$ **CHARGEMENTS:***Cas de charge décisif:* 10 ELU Horiz (3+8)*1.00**MATERIAU:**ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 160** $h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$ $b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$ $t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$ $t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{,Ed} = 0.00 \text{ kN}$ $M_{y,Ed} = 1.55 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.02 \text{ kN} \cdot \text{m}$ $N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 33 Poutres_33 POINT: 4 COORDONNEE: $x = 0.50 L = 1.225 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.01 \text{ kN}$ $M_{y,Ed} = 0.77 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.01 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.03 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.2 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.2 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 34 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.735 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.00 \text{ kN}$ $M_{y,Ed} = 1.55 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.02 \text{ kN} \cdot \text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$$N_{b,Rd} = 472.12 \text{ kN} \quad M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{N,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 35 Solives_35 **POINT:** 6 **COORDONNEE:** $x = 0.56 L = 2.042 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$tw=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$tf=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -0.00 \text{ kN}$ $M_{y,Ed} = 2.18 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.02 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.00 \text{ kN}$
 $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 186.27 \text{ kN}$
 $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = 0.01 \text{ kN}$
 $MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 131.00 \text{ kN}$
 $T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$
 Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))
 $M_{y,Ed}/MN_{y,Rd} = 0.08 < 1.00$ (6.2.9.1.(2))
 $M_{z,Ed}/MN_{z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))
 $(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.01 < 1.00$ (6.2.9.1.(6))
 $V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00$ (6.2.6-7)
 $V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00$ (6.2.6-7)
 $\tau_{ty,Ed}/(\tau_y/(\sqrt{3}\cdot gM_0)) = 0.00 < 1.00$ (6.2.6)
 $\tau_{tz,Ed}/(\tau_y/(\sqrt{3}\cdot gM_0)) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES

**Flèches (REPERE LOCAL):**

$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm}$ Vérifié

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm}$ Vérifié

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 36 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.735 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$

$t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$

$t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -0.00\text{ kN}$ $M_{y,Ed} = 1.55\text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.02\text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13\text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13\text{ kN}\cdot\text{m}$

$MN_{y,Rd} = 29.11\text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13\text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00\text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.05 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.01 < 1.00$ (6.2.9.1.(6))

$\tau_{t,Ed}/(\tau_y/(\sqrt{3}\cdot gM0)) = 0.00 < 1.00$ (6.2.6)

$$\tau_{u,tz,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 37 Solives_37 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.825 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160** $h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$ $b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$ $t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$ $t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{Ed} = -0.01 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.02 \text{ kN}\cdot\text{m}$ $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:** $N_{Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1)) $M_{y,Ed}/MN_{y,Rd} = 0.06 < 1.00$ (6.2.9.1.(2))

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^2 + (M_{z,Ed}/M_{N,z,Rd})^1 = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 38 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.735 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$


PARAMETRES DE LA SECTION: IPE 160
 $h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$
 $b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$
 $t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$
 $t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:
 $N_{,Ed} = -0.05 \text{ kN}$ $M_{y,Ed} = 1.55 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.02 \text{ kN}\cdot\text{m}$
 $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$
 $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$
 $MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$
 $T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1


PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:


en y:


en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé****Profil correct !!!****CALCUL DES STRUCTURES ACIER****NORME:** NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces**FAMILLE:****PIECE:** 39 Solives_39 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.825 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0$ cm $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2$ cm $A_y = 13.73$ cm² $A_z = 9.66$ cm² $A_x = 20.09$ cm²

$t_w = 0.5$ cm $I_y = 869.29$ cm⁴ $I_z = 68.31$ cm⁴ $I_x = 3.62$ cm⁴

$t_f = 0.7$ cm $W_{ply} = 123.86$ cm³ $W_{plz} = 26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.06$ kN $M_{y,Ed} = 1.71$ kN*m $M_{z,Ed} = -0.02$ kN*m

$N_{t,Rd} = 472.12$ kN $M_{y,pl,Rd} = 29.11$ kN*m $M_{z,pl,Rd} = 6.13$ kN*m

$M_{y,c,Rd} = 29.11$ kN*m $M_{z,c,Rd} = 6.13$ kN*m

$MN_{,y,Rd} = 29.11$ kN*m $MN_{,z,Rd} = 6.13$ kN*m

$T_{t,Ed} = 0.00$ kN*m

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.06 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:**PIECE:** 40 Solives_40 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.500 \text{ m}$ **CHARGEMENTS:***Cas de charge décisif:* 10 ELU Horiz (3+8)*1.00**MATERIAU:**ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 160** $h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$ $b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$ $t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$ $t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{,Ed} = 0.03 \text{ kN}$ $M_{y,Ed} = 1.16 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.01 \text{ kN} \cdot \text{m}$ $N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPÈRE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPÈRE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 41 Solives_41 POINT: 4 COORDONNEE: $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.01 \text{ kN}$ $M_{y,Ed} = 1.16 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.01 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL):** Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 42 Solives_42 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -0.01 \text{ kN}$ $M_{y,Ed} = 1.16 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.01 \text{ kN} \cdot \text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{N,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{t,y,Ed}/(\sigma_y/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(\sigma_y/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 43 Solives_43 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$tw=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$tf=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = -0.01 \text{ kN} \quad M_{y,Ed} = 1.16 \text{ kN}\cdot\text{m} \quad M_{z,Ed} = -0.01 \text{ kN}\cdot\text{m}$$

$$N_{t,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{N,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3}\cdot gM_0)) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3}\cdot gM_0)) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$uz = 0.0 \text{ cm} < uz_{\text{max}} = L/200.00 = 1.5 \text{ cm}$ Vérifié

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 44 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.735 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$tw = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.26 \text{ kN}$ $M_{y,Ed} = 1.55 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.02 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$MN_{,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{,Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/MN_{,y,Rd} = 0.05 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{,z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{,y,Rd})^{2.00} + (M_{z,Ed}/MN_{,z,Rd})^{1.00} = 0.01 < 1.00$ (6.2.9.1.(6))

$\tau_{t,Ed}/(\sigma_y/(\sqrt{3})\cdot\sigma_{M0}) = 0.00 < 1.00$ (6.2.6)

$\tau_{t,Ed}/(\sigma_y/(\sqrt{3})\cdot\sigma_{M0}) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES

**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 45 Solives_45 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.500 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$

$t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$

$t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -1.22\text{ kN}$ $M_{y,Ed} = 1.16\text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.01\text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13\text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13\text{ kN}\cdot\text{m}$

$MN_{y,Rd} = 29.11\text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13\text{ kN}\cdot\text{m}$

$T_{t,Ed} = -0.00\text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:



en y:



en z:

PARAMETRES DE FLAMBEMENT:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{t,Rd} = 0.00 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.04 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.00 < 1.00$ (6.2.9.1.(6))

$\tau_{t,Ed}/(\tau_y/(\sqrt{3}\cdot gM0)) = 0.00 < 1.00$ (6.2.6)

$$\tau_{u,tz,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 46 Solives_46 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$
 $b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$
 $t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$
 $t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 2.55\text{ kN}$ $M_{y,Ed} = 1.15\text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.01\text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.00\text{ kN}$
 $N_{c,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13\text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 186.24\text{ kN}$
 $N_{b,Rd} = 472.12\text{ kN}$ $M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13\text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.00\text{ kN}$
 $MN_{y,Rd} = 29.11\text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13\text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 130.99\text{ kN}$
 $T_{t,Ed} = -0.00\text{ kN}\cdot\text{m}$
 Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.01 < 1.00$ (6.2.4.(1))

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^2 + (M_{z,Ed}/M_{N,z,Rd})^1 = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 47 Solives_47 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.219 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0$ cm $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2$ cm $A_y = 13.73$ cm² $A_z = 9.66$ cm² $A_x = 20.09$ cm²

$t_w = 0.5$ cm $I_y = 869.29$ cm⁴ $I_z = 68.31$ cm⁴ $I_x = 3.62$ cm⁴

$t_f = 0.7$ cm $W_{ply} = 123.86$ cm³ $W_{plz} = 26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 5.01$ kN $M_{y,Ed} = 0.70$ kN*m $M_{z,Ed} = -0.01$ kN*m $V_{y,Ed} = -0.00$ kN

$N_{c,Rd} = 472.12$ kN $M_{y,pl,Rd} = 29.11$ kN*m $M_{z,pl,Rd} = 6.13$ kN*m $V_{y,T,Rd} = 185.53$ kN

$N_{b,Rd} = 472.12$ kN $M_{y,c,Rd} = 29.11$ kN*m $M_{z,c,Rd} = 6.13$ kN*m $V_{z,Ed} = -0.04$ kN

$MN_{y,Rd} = 29.11$ kN*m $MN_{z,Rd} = 6.13$ kN*m $V_{z,T,Rd} = 130.65$ kN

$T_{t,Ed} = -0.01$ kN*m

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.01 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.02 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\sigma_y/(\sqrt{3})\sigma_{M0}) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_x/(\sqrt{3})\sigma_{M0}) = 0.01 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.2 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.2 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces**FAMILLE:****PIECE:** 48 Solives_48 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.825 \text{ m}$ **CHARGEMENTS:***Cas de charge décisif:* 10 ELU Horiz (3+8)*1.00**MATERIAU:**ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 160** $h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$ $b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$ $t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$ $t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{,Ed} = -0.12 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.02 \text{ kN} \cdot \text{m}$ $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.06 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 49 POINT: 4 COORDONNEE: $x = 0.50 L = 1.735 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -0.07 \text{ kN}$ $M_{y,Ed} = 1.55 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.02 \text{ kN}\cdot\text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3})g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3})g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 50 Solives_50 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.825 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.13 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.02 \text{ kN} \cdot \text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$$N_{b,Rd} = 472.12 \text{ kN} \quad M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{N,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.06 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3}\cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3}\cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 51 Solives_51 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.550 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$tw=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$tf=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -3.91 \text{ kN}$ $M_{y,Ed} = 1.24 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.01 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.00 \text{ kN}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 186.27 \text{ kN}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.01 \text{ kN}$

$MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 131.00 \text{ kN}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$N_{Ed}/N_{t,Rd} = 0.01 < 1.00$ (6.2.3.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.04 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.00 < 1.00$ (6.2.9.1.(6))

$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$\tau_{ty,Ed}/(\tau_y/(\sqrt{3}\cdot gM_0)) = 0.00 < 1.00$ (6.2.6)

$\tau_{tz,Ed}/(\tau_y/(\sqrt{3}\cdot gM_0)) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES

**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 52 Solives_52 **POINT:** 1 **COORDONNEE:** x = 0.50 L = 1.750 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$

$t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$

$t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 1.69\text{ kN}$ $M_{y,Ed} = 2.39\text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.15\text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.07\text{ kN}$

$N_{c,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13\text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 185.83\text{ kN}$

$N_{b,Rd} = 472.12\text{ kN}$ $M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13\text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.11\text{ kN}$

$MN_{y,Rd} = 29.11\text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13\text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 130.80\text{ kN}$

$T_{t,Ed} = 0.00\text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{,Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.08 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.02 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.03 < 1.00$ (6.2.9.1.(6))

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 53 Solives_53 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.550 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160** $h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$ $b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$ $t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$ $t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES: $N_{,Ed} = 3.89 \text{ kN}$ $M_{y,Ed} = 1.24 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.01 \text{ kN} \cdot \text{m}$ $N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$ Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:

en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.01 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 55 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.550 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa

**PARAMETRES DE LA SECTION: IPE 160**

$h=16.0$ cm $g_{M0}=1.00$ $g_{M1}=1.00$

$b=8.2$ cm $A_y=13.73$ cm² $A_z=9.66$ cm² $A_x=20.09$ cm²

$t_w=0.5$ cm $I_y=869.29$ cm⁴ $I_z=68.31$ cm⁴ $I_x=3.62$ cm⁴

$t_f=0.7$ cm $W_{ply}=123.86$ cm³ $W_{plz}=26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.34$ kN $M_{y,Ed} = 1.24$ kN*m $M_{z,Ed} = -0.01$ kN*m

$N_{c,Rd} = 472.12$ kN $M_{y,pl,Rd} = 29.11$ kN*m $M_{z,pl,Rd} = 6.13$ kN*m

$N_{b,Rd} = 472.12$ kN $M_{y,c,Rd} = 29.11$ kN*m $M_{z,c,Rd} = 6.13$ kN*m

$MN_{,y,Rd} = 29.11$ kN*m $MN_{,z,Rd} = 6.13$ kN*m

$T_{t,Ed} = 0.00$ kN*m

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**



en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:

PIECE: 56 POINT: 7 COORDONNEE: $x = 0.50 L = 1.750 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.91 \text{ kN}$ $M_{y,Ed} = 2.39 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = 0.11 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = -0.07 \text{ kN}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{y,T,Rd} = 185.83 \text{ kN}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = 0.11 \text{ kN}$

$M_{N,y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{N,z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 130.79 \text{ kN}$

$T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.08 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.02 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.02 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 57 Solives_57 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.550 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -3.96 \text{ kN}$ $M_{y,Ed} = 1.04 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.01 \text{ kN} \cdot \text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{N,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.01 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 59 **POINT:** 7 **COORDONNEE:** $x = 0,44 L = 1.350 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 200

$h = 19.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 20.0 \text{ cm}$ $A_y = 45.12 \text{ cm}^2$ $A_z = 18.08 \text{ cm}^2$ $A_x = 53.83 \text{ cm}^2$

$t_w = 0.7 \text{ cm}$ $I_y = 3692.16 \text{ cm}^4$ $I_z = 1335.51 \text{ cm}^4$ $I_x = 21.09 \text{ cm}^4$

$t_f = 1.0 \text{ cm}$ $W_{ply} = 429.48 \text{ cm}^3$ $W_{plz} = 203.82 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 7.79 \text{ kN}$ $M_{y,Ed} = -24.47 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = 0.11 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.09 \text{ kN}$
 $N_{c,Rd} = 1265.01 \text{ kN}$ $M_{y,Ed,max} = -24.47 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = 0.11 \text{ kN}\cdot\text{m}$
 $V_{y,T,Rd} = 612.01 \text{ kN}$
 $N_{b,Rd} = 945.75 \text{ kN}$ $M_{y,c,Rd} = 100.93 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 47.90 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -18.80 \text{ kN}$
 $MN_{y,Rd} = 100.93 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 47.90 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 245.26 \text{ kN}$
 $Mb_{,Rd} = 100.93 \text{ kN}\cdot\text{m}$ $Tt_{,Ed} = -0.00 \text{ kN}\cdot\text{m}$
 Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 2392.08 \text{ kN}\cdot\text{m}$ Courbe,LT - $X_{LT} = 1.00$
 $L_{cr,low} = 1.350 \text{ m}$ $\lambda_{m,LT} = 0.21$ $f_{i,LT} = 0.50$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 3.100 \text{ m}$ $\lambda_{m,y} = 0.40$ $L_z = 3.100 \text{ m}$ $\lambda_{m,z} = 0.66$
 $L_{cr,y} = 3.100 \text{ m}$ $X_y = 0.93$ $L_{cr,z} = 3.100 \text{ m}$ $X_z = 0.75$
 $\lambda_{m,y} = 37.43$ $k_{yy} = 1.00$ $\lambda_{m,z} = 62.24$ $k_{yz} = 0.70$

flambement par torsion: flambement en flexion-torsion

Courbe,T=c $\alpha_{T,c} = 0.49$ Courbe,TF=c $\alpha_{TF,c} = 0.49$
 $L_t = 1.350 \text{ m}$ $f_{i,T} = 0.56$ $N_{cr,y} = 7962.99 \text{ kN}$ $f_{i,TF} = 0.63$
 $N_{cr,T} = 14995.50 \text{ kN}$ $X_{T,c} = 0.95$ $N_{cr,TF} = 7962.99 \text{ kN}$ $X_{TF,c} = 0.90$
 $\lambda_{m,T} = 0.29$ $Nb_{,T,Rd} = 1206.84 \text{ kN}$ $\lambda_{m,TF} = 0.40$ $Nb_{,TF,Rd} = 1136.07 \text{ kN}$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.01 < 1.00$ (6.2.4.(1))

$$M_{y,Ed}/M_{N,y,Rd} = 0.24 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.06 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.08 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 37.43 < \lambda_{max} = 210.00 \quad \lambda_{z} = 62.24 < \lambda_{max} = 210.00$$

STABLE

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.01 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.24 < 1.00 \quad (6.3.2.1.(1))$$

$$\frac{N_{Ed}/(X_y \cdot N_{Rk}/g_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1})}{1} = 0.25 < 1.00 \quad (6.3.3.(4))$$

$$\frac{N_{Ed}/(X_z \cdot N_{Rk}/g_{M1}) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1})}{1} = 0.14 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 5 \text{ ELS: CAR/1} = 1 \cdot 1.15 + 2 \cdot 1.00 \quad (1+2) \cdot 1.00$$

$$u_z = 0.2 \text{ cm} < u_{z \max} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

$$\text{Cas de charge décisif: } 11 \text{ ELS Horiz } (5+9) \cdot 1.00$$



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 61 Solives_61 POINT: 2 COORDONNEE: $x = 0.46 L = 1.433 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -0.26 \text{ kN}$ $M_{y,Ed} = 1.59 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.01 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = 0.00 \text{ kN}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{y,T,Rd} = 186.22 \text{ kN}$

$M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = -0.09 \text{ kN}$

$MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 130.98 \text{ kN}$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(\sigma_{fy}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(\sigma_{fy}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 62 Solives_62 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.750 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$

$tw=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$

$tf=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$$N_{Ed} = -0.26 \text{ kN} \quad M_{y,Ed} = 1.58 \text{ kN}\cdot\text{m} \quad M_{z,Ed} = -0.02 \text{ kN}\cdot\text{m}$$

$$N_{t,Rd} = 472.12 \text{ kN} \quad M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{N,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3}\cdot gM_0)) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3}\cdot gM_0)) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$uz = 0.1 \text{ cm} < uz_{\text{max}} = L/200.00 = 1.8 \text{ cm}$ Vérifié

Cas de charge décisif: 5 ELS:CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 64 Solives_64 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.750 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$tw = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.18 \text{ kN}$ $M_{y,Ed} = 1.58 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.02 \text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{,Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.05 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.01 < 1.00$ (6.2.9.1.(6))

$\tau_{t,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.01 < 1.00$ (6.2.6)

$\tau_{t,z,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.00 < 1.00$ (6.2.6)

DEPLACEMENTS LIMITES

**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_z \text{ max} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 65 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.735 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h=16.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=8.2\text{ cm}$ $A_y=13.73\text{ cm}^2$ $A_z=9.66\text{ cm}^2$ $A_x=20.09\text{ cm}^2$

$t_w=0.5\text{ cm}$ $I_y=869.29\text{ cm}^4$ $I_z=68.31\text{ cm}^4$ $I_x=3.62\text{ cm}^4$

$t_f=0.7\text{ cm}$ $W_{ply}=123.86\text{ cm}^3$ $W_{plz}=26.10\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 2.05\text{ kN}$ $M_{y,Ed} = 1.55\text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.02\text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12\text{ kN}$ $M_{y,pl,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13\text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12\text{ kN}$ $M_{y,c,Rd} = 29.11\text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13\text{ kN}\cdot\text{m}$

$MN_{,y,Rd} = 29.11\text{ kN}\cdot\text{m}$ $MN_{,z,Rd} = 6.13\text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00\text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{,Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/MN_{,y,Rd} = 0.05 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{,z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{,y,Rd})^{2.00} + (M_{z,Ed}/MN_{,z,Rd})^{1.00} = 0.01 < 1.00$ (6.2.9.1.(6))

$\tau_{t,Ed}/(\tau_y/(\sqrt{3}\cdot gM0)) = 0.00 < 1.00$ (6.2.6)

$$\tau_{u,tz,Ed}/(f_y/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 67 Poteau HEA 200_67 **POINT:** 2 **COORDONNEE:** x = 0.11 L = 0.450 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 200

$h=19.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$
 $b=20.0\text{ cm}$ $A_y=45.12\text{ cm}^2$ $A_z=18.08\text{ cm}^2$ $A_x=53.83\text{ cm}^2$
 $t_w=0.7\text{ cm}$ $I_y=3692.16\text{ cm}^4$ $I_z=1335.51\text{ cm}^4$ $I_x=21.09\text{ cm}^4$
 $t_f=1.0\text{ cm}$ $W_{ply}=429.48\text{ cm}^3$ $W_{plz}=203.82\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 60.71\text{ kN}$ $M_{y,Ed} = 3.05\text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.20\text{ kN}\cdot\text{m}$ $V_{y,Ed} = 0.44\text{ kN}$
 $N_{c,Rd} = 1265.01\text{ kN}$ $M_{y,Ed,max} = 18.31\text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = -1.19\text{ kN}\cdot\text{m}$
 $V_{y,c,Rd} = 612.18\text{ kN}$
 $N_{b,Rd} = 785.54\text{ kN}$ $M_{y,c,Rd} = 100.93\text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 47.90\text{ kN}\cdot\text{m}$ $V_{z,Ed} = 6.78\text{ kN}$
 $M_{N,y,Rd} = 100.93\text{ kN}\cdot\text{m}$ $M_{N,z,Rd} = 47.90\text{ kN}\cdot\text{m}$ $V_{z,c,Rd} = 245.30\text{ kN}$
 $M_{b,Rd} = 89.93\text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 0.00$ $M_{cr} = 256.53\text{ kN}\cdot\text{m}$ Courbe,LT - $X_{LT} = 0.87$
 $L_{cr,upp}=4.050\text{ m}$ $\lambda_{m_LT} = 0.63$ $f_{i,LT} = 0.75$ $X_{LT,mod} = 0.89$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 4.050\text{ m}$ $\lambda_{m_y} = 0.36$ $L_z = 4.050\text{ m}$ $\lambda_{m_z} = 0.87$
 $L_{cr,y} = 2.835\text{ m}$ $X_y = 0.94$ $L_{cr,z} = 4.050\text{ m}$ $X_z = 0.62$
 $\lambda_{m_y} = 34.23$ $k_{yy} = 1.03$ $\lambda_{m_z} = 81.31$ $k_{yz} = 0.77$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.05 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.03 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.03 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 34.23 < \lambda_{max} = 210.00 \quad \lambda_{z} = 81.31 < \lambda_{max} = 210.00$$

STABLE

$$M_{y,Ed,max}/M_{b,Rd} = 0.20 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.28 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/gM1) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.21 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$$v_x = 1.0 \text{ cm} < v_{x \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$v_y = 0.0 \text{ cm} < v_{y \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 69 Solives_69 POINT: 4 COORDONNEE: $x = 0.50 L = 1.825 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.88 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.02 \text{ kN} \cdot \text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.06 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 73 **POINT:** 7 **COORDONNEE:** $x = 0,44 L = 3.630 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 240

$h = 23.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 24.0 \text{ cm}$ $A_y = 64.54 \text{ cm}^2$ $A_z = 25.18 \text{ cm}^2$ $A_x = 76.84 \text{ cm}^2$

$t_w = 0.8 \text{ cm}$ $I_y = 7763.18 \text{ cm}^4$ $I_z = 2768.81 \text{ cm}^4$ $I_x = 41.74 \text{ cm}^4$

$t_f = 1.2 \text{ cm}$ $W_{ply} = 744.62 \text{ cm}^3$ $W_{plz} = 351.69 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.06 \text{ kN}$ $M_{y,Ed} = -16.62 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = 1.56 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -4.52 \text{ kN}$
 $N_{c,Rd} = 1805.74 \text{ kN}$ $M_{y,Ed,max} = -16.62 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = -5.04 \text{ kN}\cdot\text{m}$
 $V_{y,c,Rd} = 875.66 \text{ kN}$
 $N_{b,Rd} = 592.08 \text{ kN}$ $M_{y,c,Rd} = 174.99 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 82.65 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -9.12 \text{ kN}$
 $MN_{y,Rd} = 174.99 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 82.65 \text{ kN}\cdot\text{m}$ $V_{z,c,Rd} = 341.64 \text{ kN}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 8.230 \text{ m}$ $Lam_y = 0.87$ $L_z = 8.230 \text{ m}$ $Lam_z = 1.46$

$L_{cr,y} = 8.230 \text{ m}$ $X_y = 0.68$ $L_{cr,z} = 8.230 \text{ m}$ $X_z = 0.33$

$Lam_y = 81.88$ $k_{yy} = 1.00$ $Lam_z = 137.10$ $k_{yz} = 0.70$

flambement par torsion:

flambement en flexion-torsion

Courbe,T=c $\alpha_{T,c} = 0.49$ Courbe,TF=c $\alpha_{TF,c} = 0.49$

$L_t = 8.230 \text{ m}$ $f_{t,T} = 0.92$ $N_{cr,y} = 2375.52 \text{ kN}$ $f_{t,TF} = 1.04$

$N_{cr,T} = 3194.08 \text{ kN}$ $X_{T,c} = 0.69$ $N_{cr,TF} = 2375.52 \text{ kN}$ $X_{TF,c} = 0.62$

$Lam_T = 0.75$ $N_{b,T,Rd} = 1250.21 \text{ kN}$ $Lam_{TF} = 0.87$ $N_{b,TF,Rd} = 1114.53 \text{ kN}$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.09 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.02 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.03 < 1.00$ (6.2.9.1.(6))

$$V_{y,Ed}/V_{y,c,Rd} = 0.01 < 1.00 \quad (6.2.6.(1))$$

$$V_{z,Ed}/V_{z,c,Rd} = 0.03 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 81.88 < \lambda_{max} = 210.00 \quad \lambda_{z} = 137.10 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.14 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/gM1) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.11 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.1 \text{ cm} < u_{y \text{ max}} = L/200.00 = 4.1 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.3 \text{ cm} < u_{z \text{ max}} = L/200.00 = 4.1 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 76 Solives_76 POINT: 4 COORDONNEE: $x = 0.50 L = 1.825 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.82 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN}^*\text{m}$ $M_{z,Ed} = -0.02 \text{ kN}^*\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}^*\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}^*\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}^*\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}^*\text{m}$

$M_{N,y,Rd} = 29.11 \text{ kN}^*\text{m}$ $M_{N,z,Rd} = 6.13 \text{ kN}^*\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}^*\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.06 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3})\cdot g_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:

PIECE: 78 Solives_78 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.825 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -1.07 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.02 \text{ kN} \cdot \text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$MN_{,y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{,z,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.06 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{t,y,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPÈRE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPÈRE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 80 Solives_80 POINT: 4 COORDONNEE: $x = 0.50 L = 1.825 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = -1.95 \text{ kN}$ $M_{y,Ed} = 1.71 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.02 \text{ kN} \cdot \text{m}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$

$T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.00 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.06 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 97 Poteau HEA 200_97 **POINT:** 6 **COORDONNEE:** $x = 0.89 L = 3.600 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 200

$h = 19.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 20.0 \text{ cm}$ $A_y = 45.12 \text{ cm}^2$ $A_z = 18.08 \text{ cm}^2$ $A_x = 53.83 \text{ cm}^2$

$t_w = 0.7 \text{ cm}$ $I_y = 3692.16 \text{ cm}^4$ $I_z = 1335.51 \text{ cm}^4$ $I_x = 21.09 \text{ cm}^4$

$t_f = 1.0 \text{ cm}$ $W_{ply} = 429.48 \text{ cm}^3$ $W_{plz} = 203.82 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 78.03 \text{ kN}$ $M_{y,Ed} = -1.05 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = 0.09 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = 0.21 \text{ kN}$

$N_{c,Rd} = 1265.01 \text{ kN}$ $M_{y,Ed,max} = -6.29 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = 0.81 \text{ kN}\cdot\text{m}$
 $V_{y,c,Rd} = 612.18 \text{ kN}$

$N_{b,Rd} = 785.54 \text{ kN}$ $M_{y,c,Rd} = 100.93 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 47.90 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = 2.33 \text{ kN}$

$MN_{y,Rd} = 100.93 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 47.90 \text{ kN}\cdot\text{m}$ $V_{z,c,Rd} = 245.30 \text{ kN}$

$M_{b,Rd} = 96.35 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 0.00$ $M_{cr} = 404.33 \text{ kN}\cdot\text{m}$ Courbe,LT - $X_{LT} = 0.92$

$L_{cr,low} = 4.050 \text{ m}$ $\lambda_{m,LT} = 0.50$ $f_{t,LT} = 0.66$ $X_{LT,mod} = 0.95$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 4.050 \text{ m}$ $\lambda_{m,y} = 0.36$ $L_z = 4.050 \text{ m}$ $\lambda_{m,z} = 0.87$

$L_{cr,y} = 2.835 \text{ m}$ $X_y = 0.94$ $L_{cr,z} = 4.050 \text{ m}$ $X_z = 0.62$

$\lambda_{m,y} = 34.23$ $k_{zy} = 0.54$ $\lambda_{m,z} = 81.31$ $k_{zz} = 1.01$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.06 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/M_{N,y,Rd} = 0.01 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00$ (6.2.9.1.(6))

$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00$ (6.2.6.(1))

$V_{z,Ed}/V_{z,c,Rd} = 0.01 < 1.00$ (6.2.6.(1))

Contrôle de la stabilité globale de la barre:

$\Lambda_{y,y} = 34.23 < \Lambda_{y,max} = 210.00$ $\Lambda_{y,z} = 81.31 < \Lambda_{y,max} = 210.00$
STABLE

$M_{y,Ed,max}/M_{b,Rd} = 0.07 < 1.00$ (6.3.2.1.(1))

$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.15 < 1.00$ (6.3.3.(4))

$N_{Ed}/(X_z \cdot N_{Rk}/gM1) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.15 < 1.00$ (6.3.3.(4))

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$v_x = 0.3 \text{ cm} < v_{x,max} = L/150.00 = 2.7 \text{ cm}$ Vérifié

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$v_y = 0.9 \text{ cm} < v_{y,max} = L/150.00 = 2.7 \text{ cm}$ Vérifié

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 188 Solives_188 **POINT:** 7 **COORDONNEE:** $x = 0.35 L = 1.100 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0$ cm $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2$ cm $A_y = 13.73$ cm² $A_z = 9.66$ cm² $A_x = 20.09$ cm²

$t_w = 0.5$ cm $I_y = 869.29$ cm⁴ $I_z = 68.31$ cm⁴ $I_x = 3.62$ cm⁴

$t_f = 0.7$ cm $W_{ply} = 123.86$ cm³ $W_{plz} = 26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.12$ kN $M_{y,Ed} = 1.22$ kN*m $M_{z,Ed} = -0.01$ kN*m $V_{y,Ed} = 0.01$ kN

$N_{c,Rd} = 472.12$ kN $M_{y,pl,Rd} = 29.11$ kN*m $M_{z,pl,Rd} = 6.13$ kN*m $V_{y,T,Rd} = 186.21$ kN

$N_{b,Rd} = 472.12$ kN $M_{y,c,Rd} = 29.11$ kN*m $M_{z,c,Rd} = 6.13$ kN*m $V_{z,Ed} = 0.75$ kN

$MN_{y,Rd} = 29.11$ kN*m $MN_{z,Rd} = 6.13$ kN*m $V_{z,T,Rd} = 130.98$ kN

$T_{t,Ed} = 0.00$ kN*m

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

en y:



en z:

PARAMETRES DE FLAMBEMENT:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.01 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\sigma_y/(\sqrt{3} \cdot \sigma_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_x/(\sqrt{3} \cdot \sigma_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:**PIECE:** 189 Solives_189 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.750 \text{ m}$ **CHARGEMENTS:***Cas de charge décisif:* 10 ELU Horiz (3+8)*1.00**MATERIAU:**ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 160** $h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$ $b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$ $t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$ $t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{,Ed} = 0.02 \text{ kN}$ $M_{y,Ed} = 0.96 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.01 \text{ kN} \cdot \text{m}$ $N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.03 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{xy,Ed}/(\sigma_y/(\sqrt{3})\sigma_{M0}) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_x/(\sqrt{3})\sigma_{M0}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPÈRE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPÈRE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 237 Solives_237 POINT: 4 COORDONNEE: $x = 0.50 L = 1.500 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 0.09 \text{ kN}$ $M_{y,Ed} = 1.16 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.01 \text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES

**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00**Déplacements (REPERE GLOBAL):** Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 241 Poutres_241 **POINT:** 1 **COORDONNEE:** $x = 0.56 L = 4.600 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEB 280

$h = 28.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 28.0 \text{ cm}$ $A_y = 110.78 \text{ cm}^2$ $A_z = 41.09 \text{ cm}^2$ $A_x = 131.36 \text{ cm}^2$

$t_w = 1.1 \text{ cm}$ $I_y = 19270.30 \text{ cm}^4$ $I_z = 6594.52 \text{ cm}^4$ $I_x = 144.25 \text{ cm}^4$

$t_f = 1.8 \text{ cm}$ $W_{ply} = 1534.43 \text{ cm}^3$ $W_{plz} = 717.57 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.10 \text{ kN}$ $M_{y,Ed} = -30.26 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.03 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = -0.29 \text{ kN}$

$N_{c,Rd} = 3086.96 \text{ kN}$ $M_{y,Ed,max} = -30.26 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = 7.32 \text{ kN}\cdot\text{m}$
 $V_{y,c,Rd} = 1503.03 \text{ kN}$

$N_{b,Rd} = 1285.92 \text{ kN}$ $M_{y,c,Rd} = 360.59 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 168.63 \text{ kN}\cdot\text{m}$
 $V_{z,Ed} = 16.57 \text{ kN}$

$MN_{y,Rd} = 360.59 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 168.63 \text{ kN}\cdot\text{m}$ $V_{z,c,Rd} = 557.50 \text{ kN}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 8.230 \text{ m}$ $\lambda_{m,y} = 0.72$ $L_z = 8.230 \text{ m}$ $\lambda_{m,z} = 1.24$

$L_{cr,y} = 8.230 \text{ m}$ $X_y = 0.77$ $L_{cr,z} = 8.230 \text{ m}$ $X_z = 0.42$

$\lambda_{m,y} = 67.95$ $k_{yy} = 1.00$ $\lambda_{m,z} = 116.16$ $k_{yz} = 0.70$

flambement par torsion: flambement en flexion-torsion

Courbe,T=c $\alpha_{T,c} = 0.49$ Courbe,TF=c $\alpha_{TF,c} = 0.49$

$L_{t,c} = 8.230 \text{ m}$ $f_{i,T,c} = 0.81$ $N_{cr,y} = 5896.68 \text{ kN}$ $f_{i,TF,c} = 0.89$

$N_{cr,T} = 7675.92 \text{ kN}$ $X_{T,c} = 0.76$ $N_{cr,TF} = 5896.68 \text{ kN}$ $X_{TF,c} = 0.71$

$\lambda_{m,T} = 0.63$ $N_{b,T,Rd} = 2361.39 \text{ kN}$ $\lambda_{m,TF} = 0.72$ $N_{b,TF,Rd} = 2191.95 \text{ kN}$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/MN_{y,Rd} = 0.08 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/MN_{z,Rd} = 0.00 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.01 < 1.00$ (6.2.9.1.(6))

$V_{y,Ed}/V_{y,c,Rd} = 0.00 < 1.00$ (6.2.6.(1))

$$V_{z,Ed}/V_{z,c,Rd} = 0.03 < 1.00 \quad (6.2.6.(1))$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 67.95 < \lambda_{max} = 210.00 \quad \lambda_{z} = 116.16 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM1) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.11 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/gM1) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM1) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM1) = 0.09 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.1 \text{ cm} < u_{y \text{ max}} = L/200.00 = 4.1 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.2 \text{ cm} < u_{z \text{ max}} = L/200.00 = 4.1 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 257 Poutres 257 et 59_257 **POINT:** 2 **COORDONNEE:** x = 0.58 L = 2.042 m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \quad (1+2) \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: HEA 200**

$h = 19.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 20.0 \text{ cm}$ $A_y = 45.12 \text{ cm}^2$ $A_z = 18.08 \text{ cm}^2$ $A_x = 53.83 \text{ cm}^2$

$t_w = 0.7 \text{ cm}$ $I_y = 3692.16 \text{ cm}^4$ $I_z = 1335.51 \text{ cm}^4$ $I_x = 21.09 \text{ cm}^4$

$t_f = 1.0 \text{ cm}$ $W_{ply} = 429.48 \text{ cm}^3$ $W_{plz} = 203.82 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{,Ed} = 8.37 \text{ kN}$ $M_{y,Ed} = -27.23 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = 0.08 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = 0.06 \text{ kN}$

$N_{c,Rd} = 1265.01 \text{ kN}$ $M_{y,Ed,max} = -32.93 \text{ kN} \cdot \text{m}$ $M_{z,Ed,max} = 0.13 \text{ kN} \cdot \text{m}$
 $V_{y,T,Rd} = 608.18 \text{ kN}$

$N_{b,Rd} = 878.73 \text{ kN}$ $M_{y,c,Rd} = 100.93 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 47.90 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = 19.40 \text{ kN}$

$MN_{y,Rd} = 100.93 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 47.90 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 244.27 \text{ kN}$

$Mb_{,Rd} = 100.93 \text{ kN} \cdot \text{m}$ $Tt_{,Ed} = 0.05 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

$z = 1.00$ $M_{cr} = 1617.98 \text{ kN} \cdot \text{m}$ Courbe,LT - $X_{LT} = 1.00$

$L_{cr,low} = 1.750 \text{ m}$ $\lambda_{m_LT} = 0.25$ $f_{i,LT} = 0.52$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:

en y:



en z:

$$L_y = 3.500 \text{ m} \quad \text{Lam}_y = 0.45 \quad L_z = 3.500 \text{ m} \quad \text{Lam}_z = 0.75$$

$$\text{Lcr}_y = 3.500 \text{ m} \quad X_y = 0.91 \quad \text{Lcr}_z = 3.500 \text{ m} \quad X_z = 0.69$$

$$\text{Lam}_y = 42.26 \quad k_{yy} = 1.00 \quad \text{Lam}_z = 70.27 \quad k_{yz} = 0.70$$

flambement par torsion:

flambement en flexion-torsion

$$\text{Courbe}_T = c \quad \alpha_{T,c} = 0.49 \quad \text{Courbe}_{TF} = c \quad \alpha_{TF,c} = 0.49$$

$$L_t = 1.750 \text{ m} \quad f_{T,c} = 0.61 \quad N_{cr,y} = 6246.88 \text{ kN} \quad f_{TF,c} = 0.66$$

$$N_{cr,T} = 9662.31 \text{ kN} \quad X_T = 0.92 \quad N_{cr,TF} = 6246.88 \text{ kN} \quad X_{TF} = 0.87$$

$$\text{Lam}_T = 0.36 \quad N_{b,T,Rd} = 1160.43 \text{ kN} \quad \text{Lam}_{TF} = 0.45 \quad N_{b,TF,Rd} = 1101.23 \text{ kN}$$

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{c,Rd} = 0.01 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.27 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.07 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.08 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.02 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y,Ed} = 42.26 < \lambda_{y,max} = 210.00 \quad \lambda_{z,Ed} = 70.27 < \lambda_{z,max} = 210.00$$

STABLE

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.01 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.33 < 1.00 \quad (6.3.2.1.(1))$$

$$\frac{N_{Ed}}{X_y \cdot N_{Rk/gM1}} + \frac{k_{yy} \cdot M_{y,Ed,max}}{X_{LT} \cdot M_{y,Rk/gM1}} + \frac{k_{yz} \cdot M_{z,Ed,max}}{M_{z,Rk/gM1}} = 0.34 < 1.00 \quad (6.3.3.(4))$$

$$\frac{N_{Ed}}{X_z \cdot N_{Rk/gM1}} + \frac{k_{zy} \cdot M_{y,Ed,max}}{X_{LT} \cdot M_{y,Rk/gM1}} + \frac{k_{zz} \cdot M_{z,Ed,max}}{M_{z,Rk/gM1}} = 0.18 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00

$$u_z = 0.3 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 261 Solives_261 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.750 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 160** $h=16.0 \text{ cm}$ $gM0=1.00$ $gM1=1.00$ $b=8.2 \text{ cm}$ $A_y=13.73 \text{ cm}^2$ $A_z=9.66 \text{ cm}^2$ $A_x=20.09 \text{ cm}^2$ $t_w=0.5 \text{ cm}$ $I_y=869.29 \text{ cm}^4$ $I_z=68.31 \text{ cm}^4$ $I_x=3.62 \text{ cm}^4$ $t_f=0.7 \text{ cm}$ $W_{ply}=123.86 \text{ cm}^3$ $W_{plz}=26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{Ed} = -3.64 \text{ kN}$ $M_{y,Ed} = 1.33 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.01 \text{ kN}\cdot\text{m}$ $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

en y:



en z:

PARAMETRES DE FLAMBEMENT:**FORMULES DE VERIFICATION:***Contrôle de la résistance de la section:*

$$N_{Ed}/N_{t,Rd} = 0.01 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 262 Solives_262 **POINT:** 4 **COORDONNEE:** x = 0.50 L = 1.735 m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $g_{M0} = 1.00$ $g_{M1} = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -2.71 \text{ kN}$ $M_{y,Ed} = 1.54 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.01 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = -0.00 \text{ kN}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{y,T,Rd} = 186.25 \text{ kN}$

$M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = -0.00 \text{ kN}$

$MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 130.99 \text{ kN}$

$T_{t,Ed} = -0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.01 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(\sigma_y/(\sqrt{3} \cdot \sigma_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(\sigma_x/(\sqrt{3} \cdot \sigma_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.**TYPE D'ANALYSE:** Vérification des pièces

FAMILLE:**PIECE:** 263 Solives_263 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 1.511 \text{ m}$ **CHARGEMENTS:***Cas de charge décisif:* 10 ELU Horiz (3+8)*1.00**MATERIAU:**ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 160** $h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$ $b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$ $t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$ $t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{,Ed} = -6.35 \text{ kN}$ $M_{y,Ed} = 1.10 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.01 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = -0.00 \text{ kN}$ $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{y,T,Rd} = 185.51 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = -0.04 \text{ kN}$ $MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 130.64 \text{ kN}$ $T_{t,Ed} = -0.01 \text{ kN} \cdot \text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.01 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 264 POINT: 4 COORDONNEE: $x = 0.50 L = 1.735 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 3.20 \text{ kN}$ $M_{y,Ed} = 1.55 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.02 \text{ kN}\cdot\text{m}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$N_{b,Rd} = 472.12 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$

$$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m} \quad M_{N,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$$

$$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.01 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.05 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.01 < 1.00 \quad (6.2.9.1.(6))$$

$$\tau_{t,Ed}/(\sigma_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{t,z,Ed}/(\sigma_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 265 Solives_265 **POINT:** 4 **COORDONNEE:** $x = 0.50 L = 0.497 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -3.25 \text{ kN}$ $M_{y,Ed} = 0.09 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.00 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.00 \text{ kN}$
 $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 184.24 \text{ kN}$
 $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.01 \text{ kN}$
 $MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 130.04 \text{ kN}$
 $T_{t,Ed} = -0.02 \text{ kN}\cdot\text{m}$
Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:****PARAMETRES DE FLAMBEMENT:**

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.01 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/MN_{y,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/MN_{z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/MN_{y,Rd})^{2.00} + (M_{z,Ed}/MN_{z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(f_y/(\sqrt{3}\cdot gM_0)) = 0.03 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(f_y/(\sqrt{3}\cdot gM_0)) = 0.02 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES

**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_y \text{ max} = L/200.00 = 0.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_z \text{ max} = L/200.00 = 0.5 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 266 Poteaux U_21 **POINT:** 1 **COORDONNEE:** x = 0.00 L = 0.000 m

CHARGEMENTS:

Cas de charge décisif: 3 ELU/1=1*1.55 + 2*1.35 (1+2)*1.35

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: UAP 300**

$h=30.0\text{ cm}$ $gM0=1.00$ $gM1=1.00$

$b=10.0\text{ cm}$ $A_y=36.14\text{ cm}^2$ $A_z=30.64\text{ cm}^2$ $A_x=58.56\text{ cm}^2$

$t_w=0.9\text{ cm}$ $I_y=8170.18\text{ cm}^4$ $I_z=562.07\text{ cm}^4$ $I_x=38.46\text{ cm}^4$

$t_f=1.6\text{ cm}$ $W_{ply}=639.34\text{ cm}^3$ $W_{plz}=144.83\text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -32.62\text{ kN}$

$N_{t,Rd} = 1376.13\text{ kN}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{t,Rd} = 0.02 < 1.00$ (6.2.3.(1))

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL): Non analysé



Déplacements (REPERE GLOBAL):

$v_x = 0.1\text{ cm} < v_{x\text{ max}} = L/150.00 = 2.7\text{ cm}$ Vérifié

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$v_y = 0.6 \text{ cm} < v_{y \text{ max}} = L/150.00 = 2.7 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 268 268 **POINT:** 7 **COORDONNEE:** $x = 0.76 L = 6.305 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: HEA 400

$h = 39.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 30.0 \text{ cm}$ $A_y = 126.20 \text{ cm}^2$ $A_z = 57.33 \text{ cm}^2$ $A_x = 158.98 \text{ cm}^2$

$t_w = 1.1 \text{ cm}$ $I_y = 45069.40 \text{ cm}^4$ $I_z = 8563.83 \text{ cm}^4$ $I_x = 189.76 \text{ cm}^4$

$t_f = 1.9 \text{ cm}$ $W_{ply} = 2561.80 \text{ cm}^3$ $W_{plz} = 872.86 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.35 \text{ kN}$ $M_{y,Ed} = 54.41 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = 6.16 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -3.96 \text{ kN}$
 $N_{c,Rd} = 3736.03 \text{ kN}$ $M_{y,Ed,max} = 95.09 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = 6.16 \text{ kN}\cdot\text{m}$
 $V_{y,T,Rd} = 1701.42 \text{ kN}$
 $N_{b,Rd} = 1770.54 \text{ kN}$ $M_{y,c,Rd} = 602.02 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 205.12 \text{ kN}\cdot\text{m}$
 $V_{z,Ed} = -17.53 \text{ kN}$
 $MN_{y,Rd} = 602.02 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 205.12 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 774.99 \text{ kN}$
 $Mb,Rd = 602.02 \text{ kN}\cdot\text{m}$ $Tt,Ed = 0.21 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

$z = 1.00$ $M_{cr} = 5026.04 \text{ kN}\cdot\text{m}$ Courbe,LT - $X_{LT} = 0.97$
 $L_{cr,upp} = 2.950 \text{ m}$ $\lambda_{m,LT} = 0.35$ $f_{i,LT} = 0.57$ $X_{LT,mod} = 1.00$

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 8.325 \text{ m}$ $\lambda_{m,y} = 0.53$ $L_z = 8.325 \text{ m}$ $\lambda_{m,z} = 1.21$
 $L_{cr,y} = 8.325 \text{ m}$ $X_y = 0.92$ $L_{cr,z} = 8.325 \text{ m}$ $X_z = 0.47$
 $\lambda_{m,y} = 49.44$ $k_{yy} = 1.00$ $\lambda_{m,z} = 113.43$ $k_{yz} = 0.70$

flambement par torsion: flambement en flexion-torsion

Courbe,T=b $\alpha_{T,b} = 0.34$ Courbe,TF=b $\alpha_{TF,b} = 0.34$

$L_t = 8.325 \text{ m}$ $f_{i,T} = 0.85$ $N_{cr,y} = 13478.21 \text{ kN}$ $f_{i,TF} = 0.69$

$N_{cr,T} = 7155.42 \text{ kN}$ $X_{T,b} = 0.77$ $N_{cr,TF} = 13478.21 \text{ kN}$ $X_{TF,b} = 0.87$

$\lambda_{m,T} = 0.72$ $Nb,T,Rd = 2879.75 \text{ kN}$ $\lambda_{m,TF} = 0.53$ $Nb,TF,Rd = 3258.91 \text{ kN}$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.00 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.09 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.03 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.04 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.02 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.02 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3})\cdot gM_0) = 0.01 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 49.44 < \lambda_{max} = 210.00 \quad \lambda_{z} = 113.43 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$M_{y,Ed,max}/M_{b,Rd} = 0.16 < 1.00 \quad (6.3.2.1.(1))$$

$$N_{Ed}/(X_y \cdot N_{Rk}/gM_1) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM_1) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM_1) = 0.18 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/gM_1) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/gM_1) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/gM_1) = 0.11 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y,max} = L/200.00 = 4.2 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.5 \text{ cm} < u_{z,max} = L/200.00 = 4.2 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 269 **POINT:** 1 **COORDONNEE:** $x = 0.00$ $L = 0.000$ m

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \quad (1+2) \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: T CAR 100x5

$h = 10.0$ cm $gM0 = 1.00$ $gM1 = 1.00$

$b = 10.0$ cm $A_y = 9.44$ cm² $A_z = 9.44$ cm² $A_x = 18.88$ cm²

$t_w = 0.5$ cm $I_y = 282.80$ cm⁴ $I_z = 282.80$ cm⁴ $I_x = 438.80$ cm⁴

$t_f = 0.5$ cm $W_{ply} = 67.75$ cm³ $W_{plz} = 67.75$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 64.49$ kN $M_{y,Ed} = 0.56$ kN*m $M_{z,Ed} = 0.24$ kN*m $V_{y,Ed} = 0.13$ kN

$N_{c,Rd} = 443.68$ kN $M_{y,pl,Rd} = 15.92$ kN*m $M_{z,pl,Rd} = 15.92$ kN*m $V_{y,T,Rd} = 127.91$ kN

$N_{b,Rd} = 443.68 \text{ kN}$ $M_{y,c,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -1.12 \text{ kN}$

$M_{N,y,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $M_{N,z,Rd} = 15.92 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 127.91 \text{ kN}$

$T_{t,Ed} = 0.02 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.15 < 1.00$ (6.2.4.(1))

$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00$ (6.2.9.1.(2))

$M_{z,Ed}/M_{N,z,Rd} = 0.02 < 1.00$ (6.2.9.1.(2))

$(M_{y,Ed}/M_{N,y,Rd})^{1.70} + (M_{z,Ed}/M_{N,z,Rd})^{1.70} = 0.00 < 1.00$ (6.2.9.1.(6))

$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00$ (6.2.6-7)

$V_{z,Ed}/V_{z,T,Rd} = 0.01 < 1.00$ (6.2.6-7)

$\tau_{y,t,Ed}/(f_y/(\sqrt{3}\cdot g_{M0})) = 0.00 < 1.00$ (6.2.6)

$\tau_{z,t,Ed}/(f_y/(\sqrt{3}\cdot g_{M0})) = 0.00 < 1.00$ (6.2.6)

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 270 POINT: 7 COORDONNEE: $x = 1.00 \text{ L} = 2.210 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: $3 \text{ ELU}/1 = 1 \cdot 1.55 + 2 \cdot 1.35 \text{ (1+2)} \cdot 1.35$

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$



PARAMETRES DE LA SECTION: TCAR 100x5

$h = 10.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 10.0 \text{ cm}$ $A_y = 9.44 \text{ cm}^2$ $A_z = 9.44 \text{ cm}^2$ $A_x = 18.88 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 282.80 \text{ cm}^4$ $I_z = 282.80 \text{ cm}^4$ $I_x = 438.80 \text{ cm}^4$

$t_f = 0.5 \text{ cm}$ $W_{ply} = 67.75 \text{ cm}^3$ $W_{plz} = 67.75 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 55.20 \text{ kN}$ $M_{y,Ed} = -2.03 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = 0.00 \text{ kN} \cdot \text{m}$ $V_{y,Ed} = -0.13 \text{ kN}$

$N_{c,Rd} = 443.68 \text{ kN}$ $M_{y,pl,Rd} = 15.92 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 15.92 \text{ kN} \cdot \text{m}$ $V_{y,T,Rd} = 128.02 \text{ kN}$

$N_{b,Rd} = 443.68 \text{ kN}$ $M_{y,c,Rd} = 15.92 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 15.92 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = -1.56 \text{ kN}$

$MN_{y,Rd} = 15.92 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 15.92 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 128.02 \text{ kN}$

$$T_{t,Ed} = -0.01 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:



en y:



en z:

PARAMETRES DE FLAMBEMENT:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{c,Rd} = 0.12 < 1.00 \quad (6.2.4.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.13 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{1.69} + (M_{z,Ed}/M_{N,z,Rd})^{1.69} = 0.03 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.01 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(\sigma_{fy}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(\sigma_{fy}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:**PIECE:** 271 Solives_271 **POINT:** 1 **COORDONNEE:** $x = 0.50 L = 1.750 \text{ m}$ **CHARGEMENTS:***Cas de charge décisif:* 10 ELU Horiz (3+8)*1.00**MATERIAU:**ACIER E24 $f_y = 235.00 \text{ MPa}$ **PARAMETRES DE LA SECTION: IPE 160** $h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$ $b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$ $t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$ $t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$ **EFFORTS INTERNES ET RESISTANCES ULTIMES:** $N_{,Ed} = -4.52 \text{ kN}$ $M_{y,Ed} = 1.20 \text{ kN} \cdot \text{m}$ $M_{z,Ed} = -0.01 \text{ kN} \cdot \text{m}$ $N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $M_{y,c,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,Ed} = -0.00 \text{ kN}$ $MN_{y,Rd} = 29.11 \text{ kN} \cdot \text{m}$ $MN_{z,Rd} = 6.13 \text{ kN} \cdot \text{m}$ $V_{z,T,Rd} = 130.76 \text{ kN}$ $T_{t,Ed} = 0.00 \text{ kN} \cdot \text{m}$

Classe de la section = 1

**PARAMETRES DE DEVERSEMENT:**

PARAMETRES DE FLAMBEMENT:

en y:



en z:

FORMULES DE VERIFICATION:**Contrôle de la résistance de la section:**

$$N_{Ed}/N_{t,Rd} = 0.01 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{y,Ed}/(\tau_{y,Rd}/\sqrt{3}) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{z,Ed}/(\tau_{z,Rd}/\sqrt{3}) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES**Flèches (REPERE LOCAL):**

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.1 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.8 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00**Déplacements (REPERE GLOBAL): Non analysé**

Profil correct !!!**CALCUL DES STRUCTURES ACIER**

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 272 Solives_272 POINT: 2 COORDONNEE: $x = 0.53 L = 1.642 \text{ m}$

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00 \text{ MPa}$

**PARAMETRES DE LA SECTION: IPE 160**

$h = 16.0 \text{ cm}$ $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2 \text{ cm}$ $A_y = 13.73 \text{ cm}^2$ $A_z = 9.66 \text{ cm}^2$ $A_x = 20.09 \text{ cm}^2$

$t_w = 0.5 \text{ cm}$ $I_y = 869.29 \text{ cm}^4$ $I_z = 68.31 \text{ cm}^4$ $I_x = 3.62 \text{ cm}^4$

$t_f = 0.7 \text{ cm}$ $W_{ply} = 123.86 \text{ cm}^3$ $W_{plz} = 26.10 \text{ cm}^3$

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = -4.84 \text{ kN}$ $M_{y,Ed} = 0.94 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.01 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = -0.00 \text{ kN}$

$N_{t,Rd} = 472.12 \text{ kN}$ $M_{y,pl,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,pl,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 186.23 \text{ kN}$

$M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.07 \text{ kN}$

$MN_{y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $MN_{z,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 130.99 \text{ kN}$

$$T_{t,Ed} = 0.00 \text{ kN}\cdot\text{m}$$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:



en y:



en z:

PARAMETRES DE FLAMBEMENT:

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$$N_{Ed}/N_{t,Rd} = 0.01 < 1.00 \quad (6.2.3.(1))$$

$$M_{y,Ed}/M_{N,y,Rd} = 0.03 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.00 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{ty,Ed}/(\sigma_{fy}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

$$\tau_{tz,Ed}/(\sigma_{fy}/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \text{ max}} = L/200.00 = 1.6 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!

CALCUL DES STRUCTURES ACIER

NORME: NF EN 1993-1-1:2005/NA:2013/A1:2014, Eurocode 3: Design of steel structures.

TYPE D'ANALYSE: Vérification des pièces

FAMILLE:

PIECE: 276 Poutres_276 **POINT:** 7 **COORDONNEE:** $x = 1.00$ $L = 2.000$ m

CHARGEMENTS:

Cas de charge décisif: 10 ELU Horiz (3+8)*1.00

MATERIAU:

ACIER E24 $f_y = 235.00$ MPa



PARAMETRES DE LA SECTION: IPE 160

$h = 16.0$ cm $gM0 = 1.00$ $gM1 = 1.00$

$b = 8.2$ cm $A_y = 13.73$ cm² $A_z = 9.66$ cm² $A_x = 20.09$ cm²

$t_w = 0.5$ cm $I_y = 869.29$ cm⁴ $I_z = 68.31$ cm⁴ $I_x = 3.62$ cm⁴

$t_f = 0.7$ cm $W_{ply} = 123.86$ cm³ $W_{plz} = 26.10$ cm³

EFFORTS INTERNES ET RESISTANCES ULTIMES:

$N_{Ed} = 0.00 \text{ kN}$ $M_{y,Ed} = -0.00 \text{ kN}\cdot\text{m}$ $M_{z,Ed} = -0.26 \text{ kN}\cdot\text{m}$ $V_{y,Ed} = 0.26 \text{ kN}$

$N_{c,Rd} = 472.12 \text{ kN}$ $M_{y,Ed,max} = 0.11 \text{ kN}\cdot\text{m}$ $M_{z,Ed,max} = -0.26 \text{ kN}\cdot\text{m}$ $V_{y,T,Rd} = 185.81 \text{ kN}$

$N_{b,Rd} = 237.56 \text{ kN}$ $M_{y,c,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{z,c,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,Ed} = -0.22 \text{ kN}$

$M_{N,y,Rd} = 29.11 \text{ kN}\cdot\text{m}$ $M_{N,z,Rd} = 6.13 \text{ kN}\cdot\text{m}$ $V_{z,T,Rd} = 130.78 \text{ kN}$

$T_{t,Ed} = -0.00 \text{ kN}\cdot\text{m}$

Classe de la section = 1



PARAMETRES DE DEVERSEMENT:

PARAMETRES DE FLAMBEMENT:



en y:



en z:

$L_y = 2.000 \text{ m}$ $\lambda_{m,y} = 0.32$ $L_z = 2.000 \text{ m}$ $\lambda_{m,z} = 1.15$

$L_{cr,y} = 2.000 \text{ m}$ $X_y = 0.97$ $L_{cr,z} = 2.000 \text{ m}$ $X_z = 0.50$

$\lambda_{m,y} = 30.40$ $k_{zy} = 0.52$ $\lambda_{m,z} = 108.46$ $k_{zz} = 0.58$

flambement par torsion: flambement en flexion-torsion

Courbe,T=b $\alpha_{T,b} = 0.34$ Courbe,TF=b $\alpha_{TF,b} = 0.34$

$L_t = 2.000 \text{ m}$ $f_{t,T} = 0.80$ $N_{cr,y} = 4504.26 \text{ kN}$ $f_{t,TF} = 0.57$

$N_{cr,T} = 1068.02 \text{ kN}$ $X_{T,b} = 0.80$ $N_{cr,TF} = 4504.26 \text{ kN}$ $X_{TF,b} = 0.96$

$\lambda_{m,T} = 0.66$ $N_{b,T,Rd} = 379.19 \text{ kN}$ $\lambda_{m,TF} = 0.32$ $N_{b,TF,Rd} = 451.03 \text{ kN}$

FORMULES DE VERIFICATION:

Contrôle de la résistance de la section:

$N_{Ed}/N_{c,Rd} = 0.00 < 1.00$ (6.2.4.(1))

$$M_{y,Ed}/M_{N,y,Rd} = 0.00 < 1.00 \quad (6.2.9.1.(2))$$

$$M_{z,Ed}/M_{N,z,Rd} = 0.04 < 1.00 \quad (6.2.9.1.(2))$$

$$(M_{y,Ed}/M_{N,y,Rd})^{2.00} + (M_{z,Ed}/M_{N,z,Rd})^{1.00} = 0.04 < 1.00 \quad (6.2.9.1.(6))$$

$$V_{y,Ed}/V_{y,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$V_{z,Ed}/V_{z,T,Rd} = 0.00 < 1.00 \quad (6.2.6-7)$$

$$\tau_{xy,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.01 < 1.00 \quad (6.2.6)$$

$$\tau_{xz,Ed}/(f_y/(\sqrt{3} \cdot g_{M0})) = 0.00 < 1.00 \quad (6.2.6)$$

Contrôle de la stabilité globale de la barre:

$$\lambda_{y} = 30.40 < \lambda_{max} = 210.00 \quad \lambda_{z} = 108.46 < \lambda_{max} = 210.00 \quad \text{STABLE}$$

$$N_{Ed}/\min(N_{b,Rd}, N_{b,T,Rd}, N_{b,TF,Rd}) = 0.00 < 1.00 \quad (6.3.1)$$

$$N_{Ed}/(X_y \cdot N_{Rk}/g_{M1}) + k_{yy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{yz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.02 < 1.00 \quad (6.3.3.(4))$$

$$N_{Ed}/(X_z \cdot N_{Rk}/g_{M1}) + k_{zy} \cdot M_{y,Ed,max}/(X_{LT} \cdot M_{y,Rk}/g_{M1}) + k_{zz} \cdot M_{z,Ed,max}/(M_{z,Rk}/g_{M1}) = 0.03 < 1.00 \quad (6.3.3.(4))$$

DEPLACEMENTS LIMITES



Flèches (REPERE LOCAL):

$$u_y = 0.0 \text{ cm} < u_{y \max} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 11 ELS Horiz (5+9)*1.00

$$u_z = 0.0 \text{ cm} < u_{z \max} = L/200.00 = 1.0 \text{ cm} \quad \text{Vérifié}$$

Cas de charge décisif: 5 ELS: CAR/1=1*1.15 + 2*1.00 (1+2)*1.00



Déplacements (REPERE GLOBAL): Non analysé

Profil correct !!!